Chapter 5. Affected Environment

This chapter provides a description of the affected environment in terms of the physical, biological, cultural, and socioeconomic environments. Section 5.1 provides a regional overview of the environment. Sections 5.2 through 5.6 provide more detailed descriptions of the covered refuges in the Klamath Basin National Wildlife Refuge Complex (Refuge Complex): Upper Klamath National Wildlife Refuge (Refuge), Bear Valley Refuge, Lower Klamath Refuge, Tule Lake Refuge, and Clear Lake Refuge.

5.1 Regional Overview

5.1.1 Physical Environment

Geographic Setting

The Refuge Complex is located in northeastern California and southern Oregon (see Figure 1.1) in the Upper Klamath Basin watershed. It is situated in a high desert transition zone between the southern Cascade Range and the northern Sierra Nevada Mountains. Much of the Upper Klamath Basin was part of ancient Lake Modoc, a pluvial lake formed during the Pleistocene that covered an area of 1,100 square miles (Benke and Cushing 2005). The remnant of Lake Modoc is now Upper Klamath Lake. The surrounding lands greatly reflect the former presence of the ancient lake, and wetlands and marshes are characteristic of the area (Benke and Cushing 2005).

The Refuge Complex encompasses a wide range of habitats and topography. The average elevation is about 3,937 feet above sea level. Tule Lake Refuge and Lower Klamath Refuge are the largest and best-known refuges in the complex. Both units are situated mostly in northern California, immediately south of the Oregon state line. Upper Klamath Refuge is located in Oregon, immediately north and west of Klamath Falls. Bear Valley Refuge is also located in Oregon, 2 miles west of the town of Wordon. Clear Lake Refuge is located in northeastern California, approximately 10 miles east of Newell, California.

Climate

The Refuge Complex has a semi-arid climate with dry, hot summers and cold winters. Summer temperatures can occasionally reach 100 degrees Fahrenheit, but generally cool rapidly during the evening and nighttime hours. Nighttime temperatures can, and often do, dip below 32 degrees Fahrenheit during the summer months. January is the coldest month of the year, but frost can occur in every month. Strong winds are common, especially during winter months.

Temperature and precipitation vary with elevation, slope, and aspect. Precipitation generally occurs during the winter and spring months, with the lower elevation refuges receiving approximately 7 to 11 inches of rainfall annually. Bear Valley Refuge can receive approximately 18 to 25 inches of rainfall annually. The surrounding higher elevations receive more precipitation, which enters the Upper Klamath Basin and the Klamath River through a series of rivers and creeks. However, the Upper Klamath Basin climate includes periodic drought cycles that generally follow a 10-year pattern. During the driest years, annual precipitation can be as low as 30% of average.

The primary season for lightning activity extends from mid-May through mid- September, with occasional activity as early as April and as late as November. From mid-June through August, lightning commonly occurs unaccompanied by precipitation.

A climatic summary for the Refuge Complex region is provided in Table 5.1.

Table 5.1. Regional Climatic Summary

City	*Average Temperature (degrees Fahrenheit)*		*Average Precipitation (inches)*	*Precipitation Peak Months*
	Maximum (July)	*Minimum (Jan)*		
Klamath Falls, Oregon	85.1	21.1	13.72	November through January
Merrill, Oregon	82.6	18.6	11.48	November through January
Tulelake, California	84.6	20.1	10.92	November through January

Source: Western Regional Climate Center 2008

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has concluded that warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC 2007). The U.S. Department of Interior (DOI) issued an order in January 2001 requiring its land management agencies to consider potential climate change impacts as part of long-range planning endeavors.

Great Basin Ecoregion

All five refuges are within the northern portion of the Great Basin Ecoregion (Point Reyes Bird Observatory [PRBO] 2011). In the Great Basin, regional climate models project mean annual temperature increases of 1.7 to 2.4 degrees Celsius by 2070. For the same time period the mean diurnal temperature range is projected to increase by 0.1 to 0.2 degrees Celsius based on two regional climate models presented in Stralberg et al. (2009).

One of the greatest challenges in addressing climate change in California is that there are uncertainties associated with projections of future conditions, yet there is a need to make important long-term decisions to accommodate those potential changes (Dettinger 2005). Different global and regional climate models produce differences in the projected future climate conditions. Despite these uncertainties, there are some important generalizations for California: 1) uncertainties associated with future greenhouse-gas emissions are comparable with the differences among climate models, so that neither source of uncertainties should be neglected or underrepresented; 2) over the next 100 years, climate models currently project greater and more consistent changes in temperature than in precipitation; 3) projections of extremely wet futures for California are outliers among current projections; and 4) projections that are warmest tend to yield a moderately drier California, while the cooler projections yield a somewhat wetter future (PRBO 2011). Bell et al. (2004) also project an increase in temperature range for the ecoregion. The projected impacts of climate change on thermal conditions in the Great Basin will be warmer winter temperatures, earlier warming in the spring, later cooling in the fall, and increased summer temperatures (PRBO 2011).

Currently, there is more uncertainty about precipitation projections than for temperature projections in the Great Basin; however, the most recent investigations indicate a drier future relative to current conditions (PRBO 2011). Regional climate models project a decrease in mean annual rainfall of 32 to 85 millimeters by 2070 (PRBO 2011). On the basis of analyses of wildfire risks in California under four climatic change scenarios, Westerling and Bryant (2008) projected increases in the probability of large (more than 200 hectares) fires in the Great Basin by the end of the twenty-first century, more so under the drier, higher emissions scenario (also known as the Geophysical Fluid Dynamics Laboratory A2 scenario).

Many climate change scenarios predict shifts in vegetation concurrent with changes in temperature and precipitation patterns. Of the three major vegetation groups in the Great Basin ecoregion, increases were projected to 2070 in the area of desert scrub (51% to 63%) and eastside pine/pinyon pine/juniper (45% to 38%), and the area of the third major vegetation type, sagebrush/bitterbrush/low sage, was projected to decrease by 56% to 41% (PRBO 2011). Although they do not provide summaries of ecoregional change, maps in Lenihan et al. (2008) show vegetation shifts in the Great Basin that include an increase in the area of conifer forest and grasslands and decreases in the area of shrublands by the 2070–2099 period. These shifts may be hastened by changes in fire regimes (frequency, severity, and extent and frequency).

In the Great Basin, projected changes in climate are predicted to affect vegetation communities with potential serious consequences for wildlife (PRBO 2011). These changes will include projected increases in the amount of pine and juniper forest and desert scrub and grasslands, and a loss of sagebrush and other shrub habitats. Secondly, high temperature events will become more common, and may increase by as much as 2.7 degrees Celsius. Given the arid conditions throughout the Great Basin, this increase in temperature may increase heat and water stress for some wildlife. Lastly, snow-fed rivers and streams will have less water, especially during the spring and summer, which may reduce habitat for some wildlife associated with riparian areas.

Klamath Basin

Mayer and Naman (2011) studied how streamflow response to climate is influenced by geology and elevation. The overall objective of their study was to examine the streamflow response to these climatic trends, as mediated by geology and elevation. This section summarizes the conclusions of their study.

The climate trends in the Klamath Basin area are similar to what has been described elsewhere for the Pacific Northwest (Beebee and Manga 2004; Mote 2003). Winter temperatures in the Klamath Basin area have increased by about 1 degree Celsius since 1945 throughout the region, resulting in large decreases in spring snowpack at elevations less than 1,800 meters (average decrease of 38%), similar to findings reported for the Pacific Northwest in general (Mote 2003). Winter precipitation trends since 1945 have been less consistent and more spatially variable than temperature trends in the region. Generally, winter precipitation has decreased in some areas of southern Oregon and increased in some areas of northern California. The relative declines in spring snow water equivalent at elevations less than 1,800 meters have been much greater than the relative declines in winter precipitation in the area over the same period (Mayer and Naman 2011).

Geology and elevation are both very important in determining streamflow response to climate in the Klamath Basin region and is summarized in this section. Elevation influences temperature and the form and timing of the winter recharge signal whereas geology mediates the transition of the

winter recharge signal to streamflow. The groundwater-dominated basins have much less seasonal and annual variation and much greater summer and fall flows compared to rain and snowmelt surface-dominated basins. Warmer winter temperatures have reduced snowpack and caused earlier snowmelt throughout the region, resulting in an earlier winter recharge response in snowmelt and groundwater basins. In the groundwater basins, the streamflow response to changes in snowpack is smoothed and delayed and the effects are extended longer in the season. The snowmelt response is arriving earlier in these basins and streamflow has decreased significantly in the summer and fall. The results from Mayer and Naman (2011) indicated that absolute decreases in July through September base flows are significantly greater, by an order of magnitude or more, in groundwater basins compared to surface-dominated basins. The declines are particularly important because groundwater basins sustain Upper Klamath Lake inflows and mainstem Klamath River flows during the typically dry summers of the area. Net flow into Upper Klamath Lake decreased between 1961 and 2007, especially in the summer, and the timing of net inflow has shifted toward earlier in the spring. These changes represent major challenges for water supply and water management in the Klamath Basin (Mayer and Naman 2011).

Mayer and Naman's 2011 study shows that not all streams respond uniformly to the same climate signal. In this region, it is important to consider geology when evaluating streamflow response to climate change, both past and future. Because stream type may vary spatially at a finer scale than climate parameters like temperature and snowpack, this may necessitate studies at a smaller geographic extent than is common for most climate studies.

Effects of Climate Change on Federally Listed Lost River and Shortnose Suckers

The U.S. Fish and Wildlife Service (Service) and National Marine Fisheries Service (NMFS) summarized the potential effects of climate change on the federally listed Lost River and shortnose suckers in their Biological Opinion (BiOp) as follows (NMFS and Service 2013). Since the 1950s, western North America has experienced changes in the timing and amount of precipitation, including decreased snowfall, earlier snowmelt, and earlier peak spring runoff, which appear inconsistent with historically normal fluctuations, suggesting effects from anthropogenic sources (Hamlet et al. 2005; Knowles et al. 2006; Stewart et al. 2005). Climate models indicate that these trends are likely to continue (Barnett et al. 2008). In the upper Klamath Basin, 8 of the 10 lowest total annual inflows into Upper Klamath Lake in the past 50 years occurred between 1991 and 2009, and, over the past decade, inflows to the lake have been about 9% less than over the previous 31 years. Additionally, the July through September inflows to Upper Klamath Lake have declined by over 50% during the past 50 years (Mayer 2008; Mayer and Naman 2011).

The Lost River and shortnose suckers evolved in a region with highly variable precipitation, often with extended and severe droughts (Negrini 2002); however, given the current lack of recruitment into the adult population of each species, the absence of population connectivity (even in wet years), poor habitat conditions, and diminished abundance, Lost River and shortnose sucker populations are highly vulnerable to negative impacts from climate change, especially increased drought. Threats from climate change not only include reduction in amounts of spring runoff and its timing, but are likely to also result in increasingly reduced water quantity, the spread of disease and parasites, and proliferation of invasive and nonnative species that could prey on or compete with suckers (NMFS and Service 2013).

Geology

The Upper Klamath Basin is in a transitional zone between the Cascade Mountains and the Basin and Range Province and is dominated by the activity of large volcanoes and active faulting, which controls the location and shape of broad valleys (National Research Council [NRC] 2004). These fault-bounded valleys contain all of the large natural lakes and large wetlands of the Klamath Basin (NRC 2004).

The geology of the region is complex, with down faulted valleys and fault block mountains of the Basin and Range province terminating against the Cascade Mountains (Illian 1970). Valley fill sediments and sedimentary rocks occur as lacustrine, fluvial, and volcanoclastic deposits (Cole 2006). These deposits range in thickness from a few feet to hundreds of feet and overlie volcanic rocks (Cole 2006).

Bedrock exposed in the area is almost exclusively volcanic rock less than 6 million years old. Relatively fresh fault scarps indicate that some of the faults in the Klamath Falls area have been active in the past 10,000 years (Sherrod 1996). Earthquakes in the area are the result of ongoing, east to west crustal extension (Sherrod 1996).

Rock and mineral resources in the vicinity of the Refuge Complex consist primarily of clay and fine-grained sand, as well as limestone, shale, and basalt (Harden 2004; Oregon Department of Geology and Mineral Industries 2003; U.S. Geological Survey 2009). Basalt is more common in areas surrounding the Refuge Complex. These rock and mineral resources originated from ancient lakebed and volcanic materials that deposited in the basin over several million years. Geothermal resources, generally classified as a mineral resource, also may be present under portions of the Refuge Complex (California Department of Conservation 2002, 2003; Culver et al. 1989). However, if present, this resource would not be available for lease (30 United States Code [USC] §§ 1001-1027, as amended).

There are no active mining operations in the Refuge Complex. Additionally, there is no record of mineral exploration or historic mining in the Refuge Complex. However, records indicate the presence of several historic cinder, volcanic aggregate, pumice, lime, and shale mines in the vicinity of the Refuge Complex (Hanna and Gester 1963; U.S. Geological Survey 2008a), and a few of these resources are actively mined (U.S. Geological Survey 2008a; Nevarro 2009).

Paleontological Resources

Paleontological/paleoecological resources are defined by the Paleontologicla Resources Preservation Act (Public Law [PL] 111-011) (Omnibus Public Land Management Act of 2009) as any fossilized plants, animals, or their traces, including both organic and mineralized remains in body or trace form. Paleontological resources are studied and managed in their paleoecological context (that is, the geologic data associated with the fossil that provides information about the ancient environment). Although most geologic resources are non-renewable, all paleontological phenomena are scarce, fragile, and extremely scientifically valuable (National Park Service [NPS] 2010). Information concerning the nature and specific location of a refuge resource which is of mineral or paleontological context within units of refuges may be withheld from the public as applicable under the aforementioned policy guidance.

During the Precambrian, the area now occupied by the Refuge Complex was deep ocean. Similarly, throughout much of the early Paleozoic (Cambrian through Silurian) what is now Oregon was covered by the sea, and no rocks from these time intervals have been preserved anywhere in the state (University of California Museum of Paleontology et al. 2005).

During the middle and late Paleozoic (Devonian through Permian), tectonic activity resulted in a series of volcanic islands in the area that has become Oregon (University of California Museum of Paleontology et al. 2005). Limestones containing fossils of corals, brachiopods, and other marine animals provide evidence of the coral reefs and lagoon environments that also formed at this time, and plant fossils indicate the presence of nearby terrestrial environments (University of California Museum of Paleontology et al. 2005).

Shallow seas persisted over most of Oregon through the Mesozoic (University of California Museum of Paleontology et al. 2005). Oysters, corals, and snails were important members of the marine communities during this time interval. Vertebrates are represented by fossil fragments of pterosaurs and marine reptiles such as ichthyosaurs (University of California Museum of Paleontology et al. 2005).

Fossils of snails indicate that warm-water conditions persisted into the early Cenozoic (Tertiary) over part of Oregon (University of California Museum of Paleontology et al. 2005). Conditions became cooler and drier by the middle Tertiary. Forests of oak and alder were common, and mammals such as horses, camels, deer, and cats, as well as extinct gomphotheres (early elephants) and bear-dogs, wandered the landscape (University of California Museum of Paleontology et al. 2005).

Today, according to the Oregon Department of Geology and Mineral Industries, fossils are rare in the High Lava Plains and High Cascades, but even there, some of the lakes are famous for their fossils. Many of the sedimentary rocks in eastern Oregon contain fossil leaves or bones. Although it is rare to find a complete animal fossil, a search of riverbeds may turn up chips or even teeth (Oregon Department of Geology and Mineral Industries 2008).

Soils

Soil conditions on the covered refuges were described primarily using the Web Soil Survey, a web-based program operated by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS) (NRCS 2016). The Web Soil Survey provides access to soil data and information produced by the National Cooperative Soil Survey. The soils in the Refuge Complex vary substantially across the individual refuges. Thus, soil descriptions are provided separately for each covered refuge (Sections 5.2 through 5.6).

Hydrology

The Refuge Complex is located in the Upper Klamath Basin watershed, a 6,805-square-mile region composed of watersheds for the Williamson, Sprague, and Lost Rivers and the Upper Klamath Lake drainage (see Figure 1.1). The Oregon part of the basin (more than 5,600 square miles) lies primarily in Klamath County with smaller parts in Jackson and Lake Counties. The California part of the basin (more than 2,300 square miles) lies in Modoc and Siskiyou Counties.

In the upland areas of the basin to the north, the Wood River originates from the eastern flank of Mount Mazama (Crater Lake). To the east, the Sprague, Williamson, and Lost Rivers flow westward from more arid parts of the basin. The California portion of the basin to the south is characterized by closed lake basins that are more typical of the Basin and Range Province (U.S. Geological Survey 2008b).

Before drainage and related hydraulic manipulations, the lakes in the Klamath Basin were shallow, marsh-fringed aquatic systems (Bradbury 1992). Prior to the construction of the first irrigation ditches in the basin in the late 1800s, Lower Klamath Lake and its surrounding marshes covered approximately 80,000 acres (see Figure 1.3) (Shaw Historical Library 2008). Tule Lake was the terminal lake for the Lost River drainage, expanding to about 100,000 acres in wet weather cycles and contracting to about 55,000 acres in dry cycles (Shaw Historical Library 2008).

Today, the Upper Klamath Basin has been changed by the U.S. Bureau of Reclamation (Reclamation) Klamath Project. The Klamath Project was authorized in 1905 under provisions of the Reclamation Act of 1902 (32 Stat. 388). The project plan included construction of facilities to divert and distribute water for irrigation of basin lands, including reclamation of Tule and Lower Klamath Lakes, and control of floods in the area. Upper Klamath Basin has six mainstem dams, which are used for hydropower, supply of irrigation water, and to control and regulate the levels of flow in the river, as well as lake levels in Upper Klamath Lake.

The Klamath Project (see Figure 1.3) can provide water up to approximately 200,000 acres of croplands and 50,000 acres of refuge lakes and wetlands (Tule Lake and Lower Klamath Refuges) (Reclamation 2008). Two main sources supply water for the project: Upper Klamath Lake, and the Lost River Basin (Clear Lake Reservoir, Gerber Reservoir, and Lost River). As a result of the Klamath Project, the area of Upper Klamath Lake is approximately 61,520 acres (NRC 2008) and Tule Lake fluctuates between approximately 13,000 and 9,450 acres (NRC 2008). The major components of the Klamath Project that are relevant to refuges are discussed in more detail below.

Clear Lake Dam and Reservoir

Clear Lake Dam and Reservoir on the Lost River in California, about 19 miles southeast of Malin, Oregon, provide storage for irrigation and reduce flow into the reclaimed portion of Tule Lake and the restricted Tule Lake sumps in Tule Lake Refuge. The dam is a concrete structure with a height of 42 feet and a crest length of 840 feet. The reservoir has a capacity of 527,000 acre-feet (NMFS and Service2013).

Gerber Dam and Reservoir

Gerber Dam and Reservoir, on Miller Creek 14 miles east of Bonanza, Oregon, provide storage for irrigation and reduce flow into the reclaimed portions of Tule Lake and the restricted Tule Lake sumps in the Tule Lake Refuge. The dam, a concrete arch structure, has a height of 84.5 feet and a crest length of 460.0 feet. Reservoir capacity is 94,300 acre-feet (NMFS and Service 2013).

Link River Dam

Link River Dam on Link River at the head of the Klamath River and just west of Klamath Falls, Oregon, regulates flow from Upper Klamath Lake. This reservoir is a principal source of water for

the Klamath Project. The dam is a reinforced concrete slab structure with a height of 22 feet and a crest length of 435 feet. The reservoir has a live storage volume of 515,000 acre-feet and is operated by the Pacific Power and Light Company (now PacifiCorp), subject to Reclamation direction (NMFS and Service 2013).

Lost River Diversion Dam

Lost River Diversion Dam is on the Lost River about 4 miles below Olene, Oregon. The dam diverts excess water to the Klamath River through the Lost River Diversion Channel and restrains downstream flow in the Lost River to control or restrict flooding of the reclaimed portions of the Tule Lake bed and regulate the flow into the restricted sumps of the Tule Lake Refuge. It is a horseshoe-shaped, multiple-arch, concrete structure with earth embankment wings. The structural height is 42 feet and crest length is 675 feet (NMFS and Service 2013).

Anderson-Rose Diversion Dam

Anderson-Rose Diversion Dam (formerly Lower Lost River Diversion Dam), on the Lost River about 3 miles southeast of Merrill, Oregon, diverts water to serve the lands reclaimed from the bed of Tule Lake. The dam is a reinforced concrete slab and buttress structure with a height of 23 feet and a crest length of 324 feet (NMFS and Service 2013).

Lost River Diversion Channel

Lost River Diversion Channel extends nearly 8 miles from the Lost River Diversion Dam to the Klamath River. The channel carries excess water to the Klamath River and supplies additional irrigation water for the reclaimed lake bed of Tule Lake by reverse flow from the Klamath River (NMFS and Service 2013).

Canals, Laterals, and Drains

The Klamath Project includes 19 canals, which total 185 miles and have diversion capacities ranging from 35 to 1,150 cubic feet per second. Laterals total 490 miles and drain 545 miles (NMFS and Service 2013).

Pumping Plants

The Klamath Project includes three major pumping plants with power input ranging from 1,120 to 3,650 horsepower and capacities from 60 to 388 cubic feet per second, and 33 pumping plants of less than 1,000 horsepower (Reclamation 2013a). Reclamation is planning to construct a 60-horsepower recirculation pump in Area K.

Tule Lake Tunnel

Tule Lake Tunnel, a concrete-lined structure 6,600 feet in length with a capacity of 330 cubic feet per second, conveys drainage water from Tule Lake restricted sumps to Lower Klamath Lake (NMFS and Service 2013).

"A" Canal Tunnel

The 3,300-foot "A" Canal Tunnel, a part of the "A" Canal, has a capacity of 1,150 cubic feet per second and conveys irrigation water from Upper Klamath Lake to serve approximately 63,000 acres (NMFS and Service 2013).

Klamath Straits Drain

The Klamath Straits Drain conveys drainage water from Lower Klamath Refuge and from irrigated land that has been reclaimed from Lower Klamath Lake. The drain extends from State Line Road approximately 10 miles northwesterly to the Klamath River. The drain removes the excess winter flows and the drainage from the lower closed basin to the Klamath River.

Water Quality

Upper Klamath Lake was a naturally eutrophic body of water (NRC 2002), and presumably Lower Klamath Lake and Tule Lake also exhibited similar conditions. Major land use changes in the Klamath Basin over the last century include the draining of marshland, a decrease of forested area in the basin, an increase of agricultural land use, and overall anthropogenic activities (North Coast Regional Water Quality Control Board 2010; Oregon Department of Environmental Quality [ODEQ] 2010; Risley and Laenen 1998). These activities have resulted in increased nutrient loads to many of the waterbodies in the project area, including the Upper Klamath, Lower Klamath, and Tule Lake Refuges (Oregon Progress Board 2000), and have shifted Upper Klamath Lake and Tule Lake to a hypereutrophic status. During the warmer seasons of the year, extensive algae blooms consisting primarily of blue-green algae (Oregon Progress Board 2000) occur in Upper Klamath Lake, Tule Lake, and the Klamath River below Upper Klamath Lake (Keno Reservoir).

Reductions in riparian vegetation and associated wetlands have also contributed to nutrient loading in rivers and lakes of the region by decreasing the potential for nutrient filtration and uptake in streamside areas (Oregon Progress Board 2000).

Section 303(d) of the federal Clean Water Act and Title 40 Code of Federal Regulations (CFR) §130.7 require states to identify waterbodies that do not meet water quality standards and are not supporting their beneficial uses. These waters are placed on the Section 303(d) List of Impaired Waterbodies. The list identifies the pollutant or stressor causing impairment and establishes a schedule for developing a control plan to address the impairment.

Klamath River Hydrologic Unit, Tule Lake, and Lower Klamath Refuge are currently listed as impaired for high pH as a result of internal nutrient cycling and nonpoint sources (listing decision 20107, California State Water Resources Control Board 2015). The listing is currently being addressed by a total maximum daily load (TMDL) approved by the U.S. Environmental Protection Agency (EPA) in 2008. The beneficial use listed at risk is "preservation of areas of special biological significance."

The Klamath River Hydrologic Unit, Lost River Hydrologic Area, and Tule Lake and Mt Dome Hydrologic Sub Area include these waterbodies as well as canals and drains that surround the lakes, including the Straits Drain. Waterbodies throughout this entire area are listed as impaired for nutrients (nitrogen-ammonia or nutrients; listing decision 19510), high mercury (listing

decision 30748), low dissolved oxygen (listing decision 31211), high pH (listing decision 31128), and arsenic (EPA 2012). The EPA has approved the TMDL listing for nutrients, dissolved oxygen, and pH as of 2008. The TMDL for mercury is expected to be approved by 2025. A final arsenic TMDL has not been established in the Klamath Basin at this time. Sources of high nutrients include agriculture, habitat modification (removal of riparian vegetation), natural sources, nonpoint sources, and water diversion. Causes of low dissolved oxygen and high pH include agricultural activities and natural conditions (e.g., hydrology, geology, and meteorology). High pH is also a by-product of nutrient enrichment and high primary productivity. The cause for high mercury is unknown at this time. The cause of arsenic is thought to include both natural and anthropogenic sources. The beneficial use listed as at risk from high nutrients are fish spawning and cold freshwater habitat. The beneficial use listed at risk from low dissolved oxygen, high pH, and high mercury is cold freshwater habitat (California State Water Resources Control Board 2015). Benefical use identified in the Oregon arsenic listing includes human health and freshwater acute criteria (for human health, total inorganic arsenic 2.1 micrograms per liter [μg/L]; for freshwater aquatic life, acute and chronic [360 and 190 μg/L] [ODEQ 2014]), but human health is the constraining criteria (ODEQ 2016a).

In Oregon, low dissolved oxygen and pH water quality violations led to the 1998 303(d) listing of Upper Klamath Lake (ODEQ 2009). These TMDLs have identified a range of sources, loadings associated with impairment, and estimated load reductions to meet water quality standards throughout the project area.

In response to a challenge of EPA's approval of Oregon's temperature standard in 2005, a federal ruling in February 2012 rejected certain narrative criteria, including "natural conditions." Until this case is resolved, ODEQ is not issuing any temperature TMDLs which rely on the temperature standard's natural conditions criteria (ODEQ 2016b). As such, water temperature in Oregon TMDLs for the Lost River and Klamath River have been removed from the existing TMDLs. Because water temperature can have a direct effect on water quality processes, the parameter is still of importance in water quality assessments.

Air Quality

Air quality in the Refuge Complex can be described in terms of climate, regulatory requirements, and ambient air quality conditions. Climate and meteorology describe the atmospheric conditions, which affect the general air quality. Air quality regulations define the limits and controls on emissions necessary to maintain good air quality in the region. Ambient air quality provides a measure of the ambient concentration of various pollutants that affect air quality. This section defines the regulatory requirements for the Klamath Basin.

Federal and state governments have each established ambient air quality standards for several pollutants. Most standards have been set to protect public health. However, standards for some pollutants are based on other values, such as protecting crops and materials and avoiding nuisance conditions.

Federal Air Quality Standards

The Clean Air Act amendments of 1990 divide clean air areas into three classes, and specify the increments of sulfur dioxide (SO_2) and particulate pollution allowed in each. Upper Klamath Refuge, Bear Valley Refuge, Lower Klamath Refuge, Tule Lake Refuge, and Clear Lake Refuge

are designated as Class II quality areas. By definition, Class II areas are set aside under the Clean Air Act, but are identified for somewhat less stringent protection from air pollution damage than Class I areas. Allowable increments of new pollution are modest.

The southern boundary of Tule Lake Refuge is adjacent to Lava Beds National Monument, which encompasses over 28,600 acres. Lava Beds National Monument is designated as a mandatory federal Class I area, established under the Clean Air Act amendments of 1977, for which visibility was determined to be an important value (40 CFR 81.405).

The primary means by which the protection and enhancement of air quality is accomplished is through implementation of National Ambient Air Quality Standards (NAAQS). The U.S. Congress has promulgated these standards to regulate ambient air quality throughout the nation. The pollutants regulated under NAAQS include nitrogen dioxide (NO_2), SO_2, carbon monoxide (CO), particulate matter less than 10 microns (PM10), particulate matter less than 2.5 microns (PM2.5), and ozone (O_3). Areas where measured concentrations of these pollutants are above the NAAQS are defined as nonattainment areas. All others areas are defined as attainment areas. The refuges comprising the Refuge Complex occur in a region that has been classified as an attainment area for all NAAQS criteria pollutants (EPA 2008). The Hanks Marsh Unit of Upper Klamath Refuge is immediately adjacent to the boundary of a PM2.5 non-attainment area (see below).

State Air Quality Standards

The California Air Resources Board has adopted ambient air quality standards, which set legal limits on outdoor air pollution. The standards are designed to protect the health and welfare of Californians. The Modoc County Air Pollution Control District and Siskiyou County Air Pollution Control District are the agencies responsible for ensuring compliance with federal and state air quality standards in Modoc and Siskiyou Counties.

The most recent monitoring data (2013) for California Ambient Air Quality Standards (CAAQS) for the Northeast Plateau area (including the Klamath Basin refuges in California) is as follows (California Air Resources Board 2015). The Northeast Plateau is designated as in attainment for ozone, PM2.5, NO_2, SO_2, sulfates, and lead. For PM10, the Modoc County Air Pollution Control District, which includes Clear Lake Refuge and a portion of Tule Lake Refuge, is designated as nonattainment under CAAQS. Nonattainment is the category for an area that has one or more air quality violations within the past 3 years. For PM10, Siskiyou County, which includes Lower Klamath Refuge and a portion of Tule Lake Refuge, is designated as an attainment area (California Air Resources Board 2015). For CO, hydrogen sulfide, and visibility-reducing particles, the Northeast Plateau is designated as "unclassified." Unclassified is the category given by the California Air Resources Board to an area with insufficient data.

O_3, an important ingredient of smog, is a highly reactive and unstable gas capable of damaging the linings of the respiratory tract. This pollutant forms in the atmosphere through complex reactions between chemicals directly emitted from vehicles, industrial plants, and many other sources. Key pollutants involved in O_3 formation are hydrocarbon and NO_2 gases.

PM10 is produced by stationary point sources such as fuel combustion and industrial processes; fugitive sources, such as roadway dust from paved and unpaved roads; wind erosion from open land; and transportation sources, such as automobiles. PM10 levels in Modoc County are highest during December, when colder, more stagnant weather conditions are conducive to the buildup of PM10, including the formation of secondary ammonium nitrate (California Air Resources Board 2005). In addition, increased activity from residential wood combustion may occur at this time of year.

There are now ambient air quality standards for PM2.5, which is produced from the same sources as PM10. For PM2.5, Siskiyou County, which includes Lower Klamath Refuge and a portion of Tule Lake Refuge, is designated as an attainment area (California Air Resources Board 2015); PM2.5 levels have been of public interest to the Oregon side of the border.

ODEQ is the agency charged with developing ambient air quality standards for Oregon. Oregon ambient air quality standards are similar to those in California. Klamath County meets attainment for both state and national ambient air quality standards for PM10 and O_3, but the EPA has designated a nonattainment area around Klamath Falls for PM2.5. The nonattainment zone is slightly bigger than the urban growth boundary. The nonattainment status is a result of Klamath Falls exceding the national 24-hour standard. Woodstove smoke with a nighttime inversion during the winter months is the primary cause of this designation.

Environmental Contaminants

Since 1984, numerous pesticide investigations, published and unpublished, have been conducted at Tule Lake Refuge and Lower Klamath Refuge, as well as the surrounding area (e.g., Anderson et al. 1984; Frenzel and Anthony 1989; Hawkes and Haas 2005; Ohlendorf and Miller 1984; Mora et al. 1987; Sorenson and Schwarzbach 1991; Winchester et al. 1995). These investigations demonstrated that it is not unusual to detect one or more pesticides or their degradates in water, soil, sediment, or living tissue (Service and Reclamation 2006). However, the environmental concentration of these compounds has been relatively low and usually less than toxicological benchmarks that would indicate overt detriment to wildlife or their habitats (Service and Reclamation 2006).

When wildlife mortalities have been recorded, investigators have often concluded evidence was inconclusive (Thomson and Miller 1998), pesticide exposure occurred elsewhere (Anderson et al. 1984; Boellstorff et al. 2005; Henson et al. 1992; Mora et al. 1987) or other factors contributed to the mortality. Other contributing factors include lead poisoning (Frenzel and Anthony 1989); environmental factors such as high ammonia concentration, low dissolved oxygen, and high pH (Bennet 1994; Boyer 1993; Boyer and Grue 1994; Dileanis et al. 1996; Littleton 1993; Thomson and Miller 1998); disease; predation; physical trauma; or poor quality habitat (Grove et al. 2001; Hawkes et al. 2000; Thomson and Miller 1998).

In a study conducted at Tule Lake Refuge and Lower Klamath Refuge, Grove et al. (2001) reported two young pheasants died because of exposure to the organophosphate insecticide methamidophos, and found evidence of sublethal exposure of pheasants to insecticides that inhibit brain cholinesterase. However, Grove et al. (2001) concluded the overriding factor affecting the suppressed Tule Lake Refuge pheasant population was poor habitat quality, although loss of insects killed by insecticides may have contributed to food shortages and indirectly influenced survival.

Subsequent studies were conducted at Tule Lake in 2007 and 2011, focused on identifying if pesticides were present in Tule Lake and provided information on the potential for pesticides applied within the lease lands to reach the waters of Tule Lake. Proper pesticide application on the lease lands is of particular concern since two fish species reside in Tule Lake that are listed as endangered under the Endangered Species Act (ESA): the Lost River (*Deltistes luxatus*) and shortnose (*Chamistes brevirostris*) suckers. The objectives of the pesticide monitoring were to determine if pesticides are present in Tule Lake, determine if

detected pesticides could have originated from the lease lands, and determine if pesticide concentrations in Tule Lake are at levels great enough to be harmful to the ESA-listed suckers. The monitoring program was not intended to pinpoint the origin of detected pesticides, rather to provide insight on the potential for pesticides used in the lease lands to reach the waters of Tule Lake. Four locations were sampled every 2 weeks during the pesticide application season, from April through October, in 2007 and 2011. Three of the sampling sites were located within Tule Lake and one was located in the Lost River immediately upstream of Tule Lake. The sampling locations were selected in close proximity to the lease lands, to target areas previously known to be used by suckers, to obtain sufficient spatial coverage of Tule Lake, and to identify possible pesticide inputs from the Lost River. The results of sampling in 2007 and 2011 are presented in Table 5.1a.

Table 5.1a. Summary of Detected Compounds for the 2007 and 2011 Sampling Events

Date	*Site*	*Compound*	*Regular Sample (µg/L)*	*Duplicate Sample (µg/L)*	*Regular Sample Reanalysis (µg/L)*	*Duplicate Sample Reanalysis (µg/L)*	*Reporting Limit (µg/L)*
4/30/07	TLEC	2,4-D	0.25	0.22	NR	NR	0.20
4/30/07	LREW	Pendimethalin	0.082	N/A	NR	N/A	0.060
5/16/07	TLDH	Chlorpyrifos	0.19*	ND	ND[1]	ND[1]	0.060
5/16/07	TLDH	Oxyfluorfen	0.065	ND	ND[1]	ND[1]	0.060
5/16/07	TLDH	Pendimethalin	0.070	ND	ND[1]	ND[1]	0.060
5/16/07	TLEC	Chlorpyrifos	0.11*	N/A	Disposed	N/A	0.060
5/16/07	LREW	Pendimethalin	0.074	N/A	Disposed	N/A	0.060
5/16/17	TLNW	Chloryrifos	0.26*	N/A	Disposed	N/A	0.060
6/13/07	TLEC	Carbaryl	0.47	N/A	NR	N/A	0.12
7/26/07	TLEC	Pendimethalin	0.079	ND	ND[1]	ND[1]	0.060
4/13/11	TLDH	Bifenthrin	ND	9.0	NR	2.2	0.12
4/13/11	TLDH	Prodiamine	ND	0.14	NR	BR	0.12
4/27/11	LREW	Bifenthrin	ND	1.9	ND	ND	0.12

*Likely false detections due to in-laboratory contamination of samples.
N/A – No duplicate sample collected with regular sample.
NR – Sample not reanalyzed.
Disposed – Sample disposed of by laboratory before reanalysis could be requested.
BR – Positive but below the reporting limit.
NR – Sample not reanalyzed.
ND – Non-detect at the specified reporting limit.
ND[1] – Re-extraction and reanalysis of the sample occurred beyond the 7-day recommended hold time.

In 2007, out of 51 samples, 160 compounds, and 3,260 analyses, only two pesticide detections met data quality standards: 2,4-D (April 40, 2007) and carbaryl (June 13, 2007). The 2,4-D detection was just above the level of laboratory detection and was only 1.43% and 0.14% of the no observed effect concentration and lowest observed effect concentration, respectively. The carbaryl detection is even less concerning with the reported value at 0.24% and 0.09% of the respective no observed effect concentration and lowest observed effect concentration. Duplicates for both pendimethalin and oxyfluorfen failed to meet data quality objectives for the Project, and therefore detections may not have been valid. Similarly chlorpyrifos detections may have been due to in-laboratory contamination (see data quality section from 2007 report). Carbaryl and pendimethalin are not used on the lease lands, so the origins of the detections must have been from off-refuge locations. Likewise, if the detections of chlorpyrifos were actual detections, and not due to in-laboratory contamination, it is not likely that the chlorpyrifos originated in the lease lands because of the method of application

(method of application on refuge is a seed treatment and chlorpyrifos strongly absorbs to soil particles) and because the highest concentrations were reported in the samples obtained farthest away from the lease lands. If detections of oxyfluorfen were valid and not due to cross-contamination, it is possible, though not definitive, that the oxyflurofen originated from the lease lands. The results of the monitoring program are encouraging considering the large number of compounds investigated over the course of the entire pesticide application season, only a couple of pesticides were detected at very low levels. The results suggest that although some pesticides may be reaching Tule Lake, the concentrations are low enough that they should not be adversely affecting endangered suckers and other fish within the lake. Similarly, the monitoring conducted in 2011 suggests that no pesticides are entering Tule Lake from the application of pesticides on federal lease lands. Although the pesticide compounds bifenthrin and prodiamine were detected, these pesticides are not approved for use on the federal lease lands. This suggests that the origins of these compounds are coming from pesticide applications on land that is not under Service jurisdiction.

Historic Role of Fire

Fire has played a major role in shaping vegetative communities in the Upper Klamath Basin for millennia. However, due to a lack of fire history and fire ecology research, the area is one of the most poorly understood in California and Oregon. Recent human-induced changes in land use and fire regimes in the Upper Klamath Basin have dramatically altered many of its vegetative communities, and have presented challenges to using fire to manage landscapes.

Pre-Settlement Fire History

Prior to Euro-American settlement (ca. 1860), fires were common throughout the region. Fires in the Upper Klamath Basin were historically caused by lightning and were likely used by Native Americans. Lightning is most common between June and August, and peaks in July (Riegel et al. 2006). Ignition probability is highest from late July through September when fuel moistures are typically lowest (Riegel et al. 2006). Lightning occurrence in the region generally does not have a strong correlation with elevation (Riegel et al. 2006). The Upper Klamath Basin was heavily populated in pre-settlement times, but use of fire by humans during that time is not well documented. It is assumed that Native Americans used fire extensively in ponderosa pine forests and grasslands to enhance habitats for large game animals, supplement hunting practices, facilitate travel, and improve defense.

Fire regimes on the refuges varied greatly by vegetation type. In the ponderosa pine and dry mixed conifer forests at Bear Valley, frequent low to moderate intensity and severity fires tended to maintain open stands of large trees (Sawyer et al. 2009) with abundant grasses and forbs and limited shrub cover. Fires occurred on average every 11 years, with a range of 5 to 40 years in ponderosa pine and 5 to 50 years in dry mixed conifer forests (Van de Water and Safford 2011). A fire history study at Bear Valley analyzed fire-scarred tree rings to determine a mean fire return interval of 14 years (Goheen 1999). Sagebrush habitats at Tule Lake and Clear Lake burned every 35 years with a range of 15 to 85 years (Van de Water and Safford 2011). These fires typically burned with moderate to high intensity and high to very high severity (Sawyer et al. 2009) in a mosaic pattern. Fires were frequent enough to limit juniper encroachment into sagebrush communities. Grassland habitats likely burned at intervals of 1 to 5 years, while marsh communities on the edges of Lower Klamath and Tule Lakes probably burned only during very dry periods.

Post-settlement Fire History

Human activity after 1860 has dramatically changed the landscape in the Upper Klamath Basin. As the area was settled, Native Americans were gradually displaced therefore eliminating their intentional ignitions. Extensive livestock grazing removed much of the fine fuels that sustained low-intensity fires through grasslands and ponderosa pine/mixed conifer forests. Logging of large trees shifted species composition and altered forest structure, and active fire suppression greatly reduced the acreage burned each year in fire-dependent ecosystems.

Because of fire exclusion and logging, ponderosa pine and dry mixed conifer forests in the region are generally denser than they were in the late 1800s, and trees are much smaller (Riegel et al. 2006). Consequently, fuel loading has increased, and the risk of high-severity fires is elevated. At Clear Lake, juniper encroachment threatens crucial greater sage-grouse habitats in areas where the fire return interval is much longer than it was historically. Invading non-native annual grasses provide fuel continuity that allows fires to occur more frequently, become larger, and burn at a higher intensity and severity than they did historically. Such fires tend to eliminate sagebrush habitat in favor of non-native annual grasslands.

The Service has been recording wildfire history in the Refuge Complex for approximately 25 years; fires have occurred at all refuges in the complex. Documented fire history prior to 1990 is incomplete and shows 28 fires occurring in the Refuge Complex from 1962 to 1988. During the period 1990 to 2014, 132 wildfires fires burned 9,827 acres of Service lands (5 fires/393 acres burned per year). Most occurred between the last week in March and the first week in November. The largest amount of Service land burned in a single fire was approximately 4,300 acres at Clear Lake. About 77% of the fires were human-caused and 16% were lightning-caused (6% cause undetermined). Because of an expanding wildland-urban interface and subsequent increases in human activity, the percentage of human-caused fires is increasing. Peat fires are common in the organic soils of the former Lower Klamath and Tule Lakes, especially during periods of drought. Peat fires can burn for months below the surface and are very difficult and dangerous to suppress directly.

Prescribed Fire and Fuel Treatment History

The Refuge Complex has a long history of using prescribed fire and mechanical treatments to enhance habitats, supplement farming practices, and reduce wildfire risk to critical resources and communities. Prescribed burning and mechanical treatments have been used at all refuges in the Refuge Complex except Upper Klamath Refuge. Between 1990 and 2014, approximately 482,000 acres (19,280 acres per year) were prescribed burned, and 4,200 acres (168 acres per year) were treated mechanically.

A lease land farming program accounts for the majority of prescribed burning at Lower Klamath and Tule Lake Refuges. Prior to planting, farmers request field burns to remove crop stubble, grasses, and weeds, and to release nutrients back into the soil. Lease land fields vary in size from 40 acres to over 300 acres and are generally surrounded by roads and canals. In the past, refuge firefighters conducted most of the prescribed burning on lease land fields; however, much is now done by contract.

Fire is also used on Lower Klamath and Tule Lake Refuges to burn off decadent marsh vegetation and open up new nesting areas for migratory waterfowl. Mechanical treatments at Clear Lake Refuge are targeted to remove junipers that have invaded sagebrush habitats and restore important breeding and nesting areas for the greater sage-grouse.

Actions Required for Prescribed Burns

A burn plan is developed to address specific objectives of the prescribed burn. The burn plan prescribes a range of acceptable environmental conditions (weather, soil moisture, etc.) that would allow for the habitat objectives to be met. Each prescribed burn requires a burn plan that is reviewed and approved by the agency administrator.

Ideally, prescribed burns are done in blocks of land that are bordered by water, roads, or other unburnable vegetation. If burns are conducted in areas where adjacent fuels allow for the continued spread of fire, a fire break will need to be established prior to burning. If allowed, a tractor with a disc will be used to plow a fire break to mineral soil. This fire break will range from 10 to 20 feet in width depending on the fuels being burned. In timbered areas, hand tools such as shovels, Pulaskis, and McLeods will be used to establish a fire line down to mineral soil. Firelines in timbered fuels generally range from 1 to 3 feet in diameter depending on adjacent fuels. Chainsaws may be used to remove brush, small trees, and downed wood from the fireline. Chainsaws may also be used to limb up trees adjacent to the fireline. Hand tools may be used to construct a barrier around areas which need to be protected (pump stations, snags, signs, etc.).

In areas where sensitive features prohibit soil disturbance, fire breaks may need to be established by mowing and burning a strip of vegetation to establish a "blackline." This practice requires the use of fire engines or tracked vehicles equipped with water tanks and a crew of fire fighters to spray water as the strip of fire progresses. Blacklines are generally 10 to 20 feet in width depending on the adjacent fuels. Blacklining is very labor intensive and has a higher level of risk of escape.

Burning is generally done using propane burners mounted on all-terrain vehicles (ATVs). The ATVs are operated in a pattern to promote the acceptable level of fire behavior needed to meet objectives. Generally, four to six ATVs are used during unit ignition, but large units may require up to eight ATVs.

In areas with steep, uneven terrain, hand-held drip torches will be used to ignite prescribed fires. Drip torches allow a mixture of regular gas and diesel to flow through an ignited wick. Three to six fire fighters carrying drip torches are generally used to ignite, but unit size, fuels, and other factors may require greater or fewer individuals for ignition.

Large wetland units may require the use of airboats for ignition. Airboats allow firefighters to ignite marsh perimeters with drip torches and other ignition devices. Two to three airboats may be used for large wetland ignition.

During ignition, equipment and designated personnel will be needed to ensure that the burn stays within the unit boundaries. Heat from fuels burning along a unit boundary may cause fuels outside of the unit to ignite. Spot fires may establish outside of the unit from lofted embers or rolling material. Peat soils may ignite and penetrate beyond established fire breaks. Depending on fuels and complexity of the unit, one to two fire engines will be used for "holding" during a prescribed fire. These engines carry from 400 to 600 gallons of water and are generally staffed with a crew of two or three fire fighters. Networks of hoses may be established in conjunction with fire breaks if there is a great risk to sensitive features or an increased risk of escape along a portion of a burn. These hoses may be supplied with water via fire engines or stand-alone pumps set up in a canal, pond, or other water source.

Specialized tracked vehicles, such as Marsh Masters, are used for holding in units where conventional fire engines are not usable (such as wet conditions). The Refuge Complex has three tracked vehicles equipped with tanks and pumps which may be staffed similarly to conventional engines. One to three ATVs/UTVs equipped with small water tanks are also used on most burns. These units allow for quick access into areas not readily accessible with conventional vehicles. Tanks on these ATVs/UTVs range from 35 to 60 gallons.

Many units do not require any mop-up effort, but mop-up may be required in certain situations. If conditions dry out and residual fuels continue to burn, there is an increased threat of undesirable fire effects and an increased risk of fire escape. Mop up is generally done with a combination of water delivered via fire engines or ATVs and hand tools. Water is sprayed on the still burning fuels and hand tools are used to stir up the hot area and break up the continuity of fuels. Water may also be delivered through hoses connected to fire engines or pumps located some distance away. Regardless of the need for mop-up, units are patrolled on a daily basis by qualified fire personnel until they are declared out.

All prescribed fires are implemented using qualified personnel. A burn organization is established and a "Burn Boss" has ultimate authority on all operational aspects of the burn. All personnel are given briefings and are assigned specific roles during the burn. Firefighter and public safety is the number one priority on all prescribed burns.

A level of monitoring is done on all prescribed fires. On burns with a broad range of acceptable objectives, before and after photographs are taken and ocular estimation is used to determine if the burn was successful. Some burns with very specific objectives may require transects or other data collection prior to and after the burn to ensure that objectives are met.

5.1.2 Biological Resources

Historically, the Upper Klamath Basin was dominated by approximately 185,000 acres of shallow lakes and freshwater supplies. These extensive wetlands supported some of the greatest autumn and spring concentrations of migrating waterfowl in North America. However, during the early 1900s, many wetlands were converted to agricultural lands. Currently, less than 25% of the historical shallow wetlands remain, most of which are protected as refuge or wildlife areas. In spite of habitat losses, the Klamath Basin supports tremendous bird life, including migrating waterfowl, and the largest wintering population of bald eagles in the lower 48 states.

The Refuge Complex is situated on a major Pacific Flyway migration corridor connecting waterfowl breeding grounds in the north with major wintering grounds in California and Mexico. Five of the refuges in the complex protect habitats vital to waterfowl: Lower Klamath, Tule Lake, Upper Klamath, Klamath Marsh (not covered under this Comprehensive Conservation Plan [CCP]), and Clear Lake. The remaining refuge in the complex, Bear Valley, preserves an important winter communal roost area for bald eagles.

Vegetation and Habitat Resources

Overview of Vegetation Communities

Currently, the Refuge Complex is composed of a variety of habitats, including freshwater marshes, open water, lakes, rivers, riparian zones, coniferous forests, sagebrush and juniper uplands, grasslands, agricultural lands, and rocky cliffs and slopes. Additional information about the habitats found on specific refuges is presented in Sections 5.2 through 5.6.

Federal and State Listed Plant Species

Applegate's milk-vetch, federally listed as endangered, potentially occurs on Lower Klamath and Tule Lake Refuges given the occurrences within the vicinity, but there are no known modern occurrences. This plant species is unlikely to occur on Upper Klamath and Bear Valley Refuges because there are no known observations and there is no suitable habitat. This species is not on the official federal species list for the other refuges (Appendix S).

Greene's tuctoria, federally listed as endangered, is unlikely to occur on Lower Klamath, Clear Lake, and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This plant species is not on the official federal species lists for the other refuges (Appendix S). Therefore, it will not be addressed further in the CCP.

Slender Orcutt grass, federally listed as threatened, potentially occurs on Clear Lake Refuge given occurrences within the vicinity, but there are no known modern occurrences. Slender Orcutt grass is unlikely to occur on Lower Klamath and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This plant species is not on the official federal species lists for the other refuges (Appendix S). It is listed by the State of California.

Whitebark pine, a candidate species for federal listing under the ESA, is unlikely to occur on Lower Klamath, Clear Lake, and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This plant species is not on the official federal species lists for the other refuges (Appendix S). Therefore, it will not be addressed further in this CCP.

Federal- and state-listed species are summarized in Table 5.4.

Invasive/Non-Native Plant Species

When plants that evolved in one region of the globe are moved to another region, a few flourish, crowding out native vegetation and the wildlife that feeds on them. These invasive plants have a competitive advantage because they are no longer controlled by their natural predators and can quickly spread out of control. The scientific community has come to view invasive species as posing serious threats to biological diversity, second only to the threats resulting from habitat loss and fragmentation (Bossard et al. 2000). Invasive species present complex management issues; even when the species are no longer being actively introduced, they continue to spread and invade new areas. Invasive species affect native species and habitats in several ways, including the alteration of nutrient cycles, fire frequency and/or intensity, and hydrologic cycles, by creating changes in sediment deposition and erosion, dominating habitats and displacing native species, and hybridizing with native species (Bossard et al. 2000). In California, approximately 3% of the plant species growing in the wild are considered invasive, but they inhabit a much greater proportion of the landscape (California Invasive Plant Council 2007). In Oregon, it has been estimated that existing and potential invasive weeds are costing Oregonians about $100 million per year (Oregon Department of Agriculture [ODA] 2000).

Plant pests are defined by law, regulation, and technical organizations, and are regulated by many different sources, including the California Department of Food and Agriculture (CDFA), ODA, and the U.S. Department of Agriculture (USDA).

The CDFA uses an action-oriented pest-rating system. The rating assigned to a pest by the CDFA does not necessarily mean that one with a low rating is not a problem; rather the rating system is meant to prioritize response by the CDFA and county agricultural commissioners. The purpose of the ODA classification system is to act as the ODA's official guideline for prioritizing and implementing noxious weed control projects, assist the ODA in the distribution of available funds for Oregon State Weed Board grants and county noxious weed control requests, and serve as a model for the private and public sectors in developing noxious weed classification systems. The CDFA and ODA list categories are explained in more detail in Table 5.2.

Table 5.2. Categories for Invasive Plants and Noxious Weeds

California Department of Food and Agriculture Categories	
A	An organism of known economic importance subject to state (or commissioner when acting as a state agent) enforced action involving: eradication, quarantine, containment, rejection, or other holding action.
B	An organism of known economic importance subject to: eradication, containment, control or other holding action at the discretion of the individual county agricultural commissioner; or an organism of known economic importance subject to state endorsed holding action and eradication only when found in a nursery.
C	An organism subject to no state enforced action outside of nurseries except to retard spread at the discretion of the commissioner; or an organism subject to no state enforced action except to provide for pest cleanliness in nurseries.
Q	An organism or disorder requiring temporary "A" action pending determination of a permanent rating. The organism is suspected to be of economic importance but its status is uncertain because of incomplete identification or inadequate information. In the case of an established infestation, at the discretion of the Assistant Director for Plant Industry, the Department will conduct surveys and will convene the Division Pest Study Team to determine a permanent rating.
D	No action.
Oregon Department of Agriculture Categories	
A	Designated weed – a weed of known economic importance which occurs in the state in small enough infestations to make eradication or containment possible; or is not known to occur but its presence in neighboring states make future occurrence in Oregon seem imminent. Recommend action: infestations are subject to eradication or intensive control when and where found.
B	Designated weed – a weed of economic importance which is regionally abundant, but which may have limited distribution in some counties. Recommended action: limited to intensive control at the state, county, or regional level as determined on a case-by-case basis. Where implementation of a fully integrated statewide management plan is not feasible, biological control (when available) shall be the main control methods.
T	Designated weed – a priority noxious weed designated by the Oregon State Weed Board as a target on which the ODA will develop and implement a statewide management plan. "T" designated noxious weeds are species selected from either the "A" or "B" list.

Source: California Department of Food and Agriculture (CDFA) 2010; and Oregon Department of Agriculture (2000).

Invasive plant species known to occur on or near the Refuge Complex were determined using Weedmapper.Org (ODA et al. 2009) and Refuge Complex records. The results are presented in Table 5.3.

Fish and Wildlife

The habitats of the Upper Klamath Basin support diverse and abundant populations of resident and migratory wildlife. A general description of the wildlife occurring in the Refuge Complex is provided below, and a list of all wildlife species present, or potentially present, is provided in Appendix H. Additional refuge-specific information is provided in Sections 5.2 through 5.6.

Migrating Waterfowl

The Refuge Complex is internationally renowned for its great abundance and diversity of birdlife. Approximately 80% of migrating waterfowl on the Pacific Flyway pass through the Klamath Basin on both spring and fall migrations.

Clear Lake, Tule Lake, and Lower Klamath Refuges are part of the Klamath Basin – Clear Lake Important Bird Area (IBA) and Upper Klamath Refuge is part of the Upper Klamath Lake IBA. The IBA program is a global effort to identify and conserve areas that are vital to birds and other biodiversity. By working with Audubon chapters, landowners, public agencies, community groups, and other non-profits, Audubon endeavors to interest and activate a broad network of supporters to ensure that all IBAs are properly managed and conserved.

Table 5.3. Invasive Plant Species Known to Occur on or Near the Klamath Basin Refuge Complex

Species	*CDFA/ODA Designation*
Canada thistle	B/B
Diffuse knapweed	A/B
Kochia	--/B
Mediterranean sage	B/B
Musk thistle	A/B
Perennial pepperweed	B/B
Poison hemlock	--/B
Puncturevine	C/B
Scotch thistle	A/B
Spotted knapweed	A/B, T
St. John's wort	C/B
Whitetop	B/B
Yellow flag iris	--/B
Yellow star thistle	C/B, T

To qualify as an IBA, sites must satisfy a variety of criteria. In the United States, the IBA program has become a key component of many bird conservation efforts, including Partners in Flight, the North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan. The Upper Klamath Lake IBA was selected and approved because it supports one of the few remaining nesting areas for American white pelicans in the western United States, a white-faced ibis breeding colony, and nesting great egrets and black-crowned night herons. In addition, Service census migration data indicate hundreds of thousands of ducks, tens of thousands of geese, and thousands of tundra swans use the area.

The Klamath Basin – Clear Lake IBA was selected and approved because it supports California's entire breeding population of America white pelicans, greater than 10% of California's breeding population of white-faced ibises, 20 sensitive bird species, greater than 10,000 shorebirds, and greater than 5,000 waterfowl (Cooper 2004).

Of special interest in the Refuge Complex are the large concentrations of waterfowl during spring and fall migratory periods. The Refuge Complex is situated on a major Pacific Flyway migration corridor connecting waterfowl breeding grounds in the north with major wintering grounds in

California and Mexico, and refuge wetlands are among the most prolific waterfowl and marsh bird production areas in the Pacific Northwest. Starting in 1953, standardized waterfowl surveys from small aircraft have been conducted in autumn through spring in the Refuge Complex. Data from these surveys were analyzed in *Waterfowl Migration on the Klamath Basin National Wildlife Refuges 1953-2001* (Gilmer et al. 2004) and are summarized below.

In the Refuge Complex, waterfowl abundance, species composition, and distribution have fluctuated over the decades; and have been influenced by events such as productivity on breeding grounds and habitat conditions on wintering grounds, which cause shifts in migration patterns.

Over the long term, waterfowl abundance (birds per day) on the Refuge Complex averaged about 1.0 million birds in autumn and about 360,000 in spring. A record peak count of 5.8 million waterfowl was recorded September 24 and 25, 1958. After reaching record levels in the 1950s and early 1960s, average abundance of autumn staging waterfowl for the Refuge Complex began a decline that lasted until the 1980s. A gradual recovery occurred during the 1990s, but autumn abundance has not recovered to pre-1970 levels. In contrast to autumn, average spring abundance was generally lower in the early decades but has gradually increased through the 1990s, particularly on Lower Klamath Refuge.

Dabbling ducks represented an average of 68% of all waterfowl in autumn and 55% in spring over the long term. Northern pintails were dominant, representing 62% of all dabblers in autumn and 51% in spring. A substantial decline in pintail abundance starting in the late 1950s altered waterfowl composition on refuges in the complex. As pintails declined, other species, such as mallards and green-winged teals, increased in abundance.

Although Arctic nesting geese, including white-fronted, cackling Canada, and white geese (lesser snow and Ross's), have become less prominent in recent decades, they reached a historically high abundance during autumn in the 1960s and 1970s, particularly on Tule Lake Refuge.

Tule Lake Refuge supported the highest average autumn waterfowl populations until surpassed by Lower Klamath Refuge around 1980. During the recent period (1977–2001), Lower Klamath Refuge accounted for 60% of all waterfowl using the Refuge Complex in autumn and 61% in spring. Habitat diversity and wetland productivity contributed to its greater waterfowl abundance. Tule Lake Refuge supported the most geese over the long term (79% in autumn and 66% in spring); however, total waterfowl abundance on the refuge in autumn has been in decline, likely because of reduced diversity and productivity of sumps on the refuge. Upper Klamath, Klamath Marsh, and Clear Lake Refuges accounted for less than 8% of total waterfowl use in autumn and spring but provided diverse habitats for migrants.

Waterfowl use-days in the Refuge Complex typically peaked in mid-autumn, decreased as migrants passed through the basin, and then reached a lesser peak during spring passage. Waterfowl abundance reached a pronounced peak in autumn during the early period (1953–1976), but spring peak buildup was much less pronounced. For the recent period, the autumn peak was more subdued.

Breeding Waterfowl

Lower Klamath and Tule Lake Refuges are considered among the premiere managed wetland areas in the west for waterfowl production, producing up to 50,000 ducklings per year (Jensen and Chattin 1964). In the more recent period, duck production has averaged 28,528, 6,670, and 1,490 on Lower Klamath, Tule Lake, and Upper Klamath Refuges, respectively. Goose production has averaged 789, 142, and 765 birds on Lower Klamath, Tule Lake, and Upper Klamath Refuges, respectively.

Molting Waterfowl

As the result of a total molt of wing feathers, adult waterfowl become flightless for a 30-day period each summer (Weller 1976). Waterfowl often leave breeding areas and may fly large distances to seek secure habitat during this time period (Ringelman 1990). Male mallards begin the molt in mid-July with females initiating the molt approximately 30 days later. The molting period for mallards extends from mid-July through September.

Generally, the Service does not conduct aerial waterfowl surveys during the late summer molting period; however, an aerial survey conducted July 26, 2003, estimated that 95,000 and 90,100 mallards were present on Lower Klamath and Tule Lake Refuges, respectively, for a total of 185,100 mallards (Klamath Basin Refuge data). An additional 15,050 and 70,200 gadwall (*A. strepera*) on Lower Klamath and Tule Lake Refuges, respectively, were counted on this survey. This total would represent approximately 55% of the mallards counted in California during the preceding May 2003 mallard breeding population survey (breeding waterfowl population estimates from California Department of Fish and Game data).

About half of the mallards that breed in the California Central Valley (S. L. Oldenburger, California Department of Fish and Game, unpublished data; Yarris et al. 1994), nearly all that breed in the Klamath Basin (Mauser 1991), and other duck species (Miller et al. 1992) use Klamath Basin wetlands during late summer to undergo wing molt. Of the female mallards that molt in the Klamath Basin, 37% use the marshes of Upper Klamath Lake, 37% use Tule Lake Refuge, and 26% use Lower Klamath Refuge (Fleskes et al. 2010; S. L. Oldenburger, California Department of Fish and Game, unpublished data; Yarris et al. 1994). Yarris et al. (1994) determined that mallards tend to molt in permanently flooded wetlands and were likely attracted to the relatively large acreage of this wetland type in the Klamath Basin, especially given the near total loss of large emergent wetlands in the Central Valley of California.

Nongame Waterbirds

Nongame waterbirds are broadly grouped as shorebirds, gulls, terns, cranes, rails, herons, grebes, egrets, and ibis. Nongame waterbirds known to occur on the Refuge Complex are listed in Appendix H. Loss of historic wetlands and unregulated market hunting of waterbirds at historic Tule and Lower Klamath Lakes, early in the twentieth century, resulted in major declines in waterbird abundance in the Klamath Basin, particularly colonial nesting species. Lower Klamath Refuge, in particular, was established largely to protect nesting colonies from unregulated hunting (Weddell et al. 1998). Intensive habitat management on remaining wetland areas of both Tule Lake and Lower Klamath Refuges has offset some losses and provides habitat for remaining populations. Lower Klamath Refuge is considered the most significant waterbird nesting site in California (Ivey and Herziger 2006). Within the Intermountain West Joint Venture (IMWJV)

waterbird conservation plan, wetlands of Klamath Basin are identified as significant waterbird habitat areas. Securing a reliable water supplies for Lower Klamath Refuge is considered a "critical conservation need" (Ivey and Herziger 2006).

For some species, Klamath Basin wetlands are considered of regional and continental significance (Shuford 2010; Shuford et al. 2006). Shuford et al. (2006) conducted comprehensive surveys of nongame waterbirds throughout the Klamath Basin during May, June, and August of 2003 and 2004. For the Klamath Basin above Keno, observed numbers ranged from 52,737 to 89,799 individuals representing 50 species. These counts are considered minimums for two reasons: 1) many species of nongame waterbirds are extremely secretive or small and/or cryptically colored making them difficult to observe, and 2) counts in July and August were conducted during the migratory phase for many species. Waterbirds using the basin in migration either before or after surveys were not counted (Shuford et al. 2006).

Based on Shuford et al. (2006), Tule Lake and Lower Klamath Refuges support 9% to 24% and 25% to 41%, respectively, of the nongame waterbirds in the Klamath Basin. Lower Klamath Refuge is particularly important to migrant and breeding shorebirds, breeding American white pelicans (*Pelecanus erythrorhynchos*) (one of only two breeding colonies in California), eared grebes (*Podiceps nigricollis*), breeding white-faced ibis (*Plegadis chihi*) (one of the largest colonies in the Intermountain West), Franklin's gulls (*Leucophaeus pipixcan*), and Forster's (*Sterna forsteri*) and black terns (*Chlidonias niger*). Tule Lake Refuge is notable for breeding eared and western (*Aechmophorus occidentalis*)/Clark's grebes (*A. clarkii*), migrant shorebirds, and fall staging black terns. Upper Klamath Refuge supports large numbers of breeding western/Clark's grebes, American white pelicans, double-crested cormorants (*Phalacrocorax auritus*), and Forster's and black terns (Shuford et al. 2006).

Historically large numbers of waterbirds bred on islands within Klamath Basin wetlands (see Weddell et al. 1998 for historic accounts). Because nearly all of the historic islands are gone, in 2010 the Service, Oregon State University, Realtime Research, Inc., and the U.S. Army Corps of Engineers partnered in the construction of three artificial nesting islands on Tule Lake (one island) and Lower Klamath (two islands) Refuges. The overall aim of the project is to redistribute nesting Caspian terns (*Hydroprogne caspia*) from the Columbia River estuary to other suitable locations in the western United States (Service 2005). In addition to Caspian terns, constructed nesting islands also serve other nesting species. Because of project water shortages in 2010, only one island on Lower Klamath Refuge was functional supporting 258 Caspian tern nests (167 fledglings), as well as 151 and 744 California (*Larus californicus*) and ring-billed gull (*L. delawarensis*) nests, respectively. Since 2010, water shortages have continued to reduce the availability of habitat for waterbirds.

Songbirds

Songbirds include a wide array of landbirds such as hummingbirds and woodpeckers, as well as the large order of birds called passerines or "perching" birds. Passerines comprise more than half the world's species of birds, and all have a perching foot that includes three toes forward and one toe backward. They range in size from wrens to ravens and include flycatchers, shrikes, vireos, crows, jays, chickadees, nuthatches, tanagers, cardinals, sparrows, and finches. Songbirds known to occur on the Refuge Complex are listed in Appendix H.

Raptors

Raptors are birds adapted for a carnivorous diet. They typically have a strong decurved bill and sharp piercing talons used to capture prey. More than 25 species of raptors, including vultures, hawks, owls, and eagles, have been sighted on the covered refuges (see Appendix H). Several species nest on the refuges and many others migrate through during spring and fall. Although bald eagles are the most visually conspicuous raptor species and receive the bulk of the attention, the Upper Klamath Basin is also a wintering area for thousands of northern harriers, rough-legged hawks, and red-tailed hawks. These species make extensive use of agricultural areas where rodent populations are high. Some of the raptors known to be nesting on or immediately adjacent to the refuges in the complex include the red-tailed hawk, great horned owl, bald eagle, great gray owl, golden eagle, and northern goshawk.

The relatively mild winters and abundant food resources in the Upper Klamath Basin attract the largest wintering population of bald eagles (*Haliaeetus leucocephalus*) in the United States outside of Alaska (Keister et al. 1987; Manning and Edge 2002). Lower Klamath and Tule Lake Refuges with their large wintering populations of waterfowl attract the largest numbers of eagles in the basin. Waterfowl represents a very high-quality food item for eagles due to its high digestibility and fat content (Stalmaster 1987); however, the number of waterfowl required in the diet is relatively high (135/year) because of the small amount of food within each carcass (Stalmaster and Gessaman 1984). In addition to waterfowl, wintering eagles forage on small mammals which are forced from their burrows when agricultural fields are flood irrigated in late winter (Keister 1981).

Eagles begin arriving in the Klamath Basin in November with peak populations usually occurring in February. Although the basin supports large populations of local birds in the winter, eagles have been documented to use the basin from as far as northeastern Alaska and northwest Canada (Young 1983) and from throughout the Northwest, California, and Arizona (Frenzel 1985). There are three primary foraging areas in the Upper Klamath Basin for wintering eagles: Lower Klamath and Tule Lake Refuges and lands within the Klamath Drainage District. In addition, five additional sites, near Lower Klamath and Tule Lake Basins, are used as communal night roosts (Keister et al. 1987).

Areas in the Pacific Northwest that support large wintering concentrations of eagles are relatively uncommon with all sites sharing unique habitat characteristics. These sites contain adequate food resources on a consistent basis, are relatively free from human disturbance, are generally open in nature, and contain adequate roosting sites nearby (Stalmaster 1987). The Upper Klamath Basin possesses all of these characteristics. Prior to European settlement, large numbers of wintering eagles congregated on salmon spawning streams in the Pacific Northwest. Unfortunately, declining salmon populations have eliminated many of these former wintering sites (Stalmaster 1987).

In addition to wintering eagles, the Klamath Basin hosts large numbers of nesting eagles particularly around Upper Klamath Lake. From 2003 to 2007, the number of active nests in the Klamath Basin ranged from 126 to 136. Successful nests fledged an average of 1.53 eaglets per year (Isaacs and Anthony 2008). In 2009, the first bald eagle nest in at least 30 years was initiated on Lower Klamath Refuge. The pair successfully reared one young each in 2009 and 2010.

Mammals

Most of the mammals found on the covered refuges are year-round residents. Small mammals present include several species of shrews, moles, squirrels, gophers, rabbits, mice, and bats. Large mammals commonly found include the mule deer, pronghorn antelope, badger, striped skunk, bobcat, black bear, and coyote. In addition, muskrat, beaver, and river otter are found in the aquatic habitats of the refuges. A complete list of mammal species known to use the refuges is included in Appendix H. The wetlands of Tule Lake and Lower Klamath Refuges are summer foraging areas for bats.

Reptiles and Amphibians

A variety of reptiles and amphibians are found on the covered refuges. Amphibians, such as the Pacific treefrog, typically prefer aquatic or moist habitats such as marshes, ditches, and streams while reptiles, such as the western skink and gopher snake, are usually found in grassy or rocky dry upland habitats. Multiple species of reptiles and amphibians occur on the five Klamath Basin refuges (see Appendix H).

Fishes

A variety of fish species is present in the waters of the Klamath Basin. Many of these species play an important role by serving as an abundant food source for the many fish-eating species in the region (see Appendix H for a list of fish species known to occur on the Refuge Complex).

The Upper Klamath Basin is an ancient, isolated, and unusual environment for fish. Thus, most, or possibly all, of the native species that live in the upper basin are endemic to it (NRC 2004). Only five families of fishes—Petromyzontidae (lampreys), Cyprinidae (minnows), Catostomidae (suckers), Salmonidae (salmon and trout), and Cottidae (sculpins)—are native to the upper basin, and the species in these families have many unusual adaptations to the environment of the basin (NRC 2004). Native fish species occurring in the Refuge Complex include the shortnose sucker and Lost River sucker, both federally listed as endangered species (see Federal and State Listed Species below), as well as lamprey (i.e., Pacific lamprey and Pit-Klamath brook lamprey), minnows (i.e., tui chub and blue chub), sculpin (i.e., Klamath Lake sculpin, marbled sculpin, and slender sculpin), and the Klamath redband trout.

Invertebrates

Invertebrates are animals that have no backbone or spinal column. Corals, insects, worms, jellyfish, starfish, and snails are examples of invertebrates. Invertebrates play in important role in fish and wildlife ecology on the covered refuges, comprising a critical food base for many species that use the refuges. They occur in all habitat types, both aquatic and terrestrial. Some are abundant, such as many species of midges, while others are quite rare.

In combination with seeds and other vegetation, aquatic invertebrates are an essential part of many waterbird diets at various times of the year because they provide a balance of amino and fatty acids to facilitate fat and protein storage (Euliss and Harris 1987; Heitmeyer and Raveling 1988; Miller 1987). Invertebrates provide energy for migration, protein to replace molted feathers, and calcium for the production of eggs. Wetlands support a wide variety of aquatic invertebrates, including water fleas, snails, clams, dragonflies, damselflies, water boatmen, backswimmers,

beetles, midges, mosquitoes, worms, mussels, crayfish, and various species of zooplankton. While many of these species larvae occur in the water column or sediment in wetlands, the adult stages are aerial and an important food source for landbirds and some mammals (e.g., swallows, flycatchers, and bats).

Terrestrial invertebrates are also an important food base for many migratory and resident bird species, and include numerous species of grasshoppers, beetles, butterflies, moths, ants, spiders, and other insects. In addition, many of these invertebrates play key roles in plant pollination.

Federal and State Listed Fish and Wildlife Species

A list of special-status species known to occur or potentially occurring on the covered refuges is included as Appendix H, which includes federal- and state-listed threatened and endangered species, species proposed for threatened or endangered status, and candidate species. Other special-status species (e.g., California Department of Fish and Wildlife [CDFW] species of special concern and Oregon Department of Fish and Wildlife [ODFW] sensitive species) are also included in Appendix H. **Federally listed and state-listed species are summarized in Table 5.4. Federally listed species are also addressed in Appendix S.**

Table 5.4 summarizes federally and state-listed, proposed, and candidate fish, wildlife, and plants that are known to occur or with potential to occur on the Klamath Basin refuges.

Federally listed and state-listed species that have been documented on the five Klamath Basin refuges are described below and additional information about their occurrence on individual refuges is provided in Appendix H.

Table 5.4. Federally Listed and State-Listed Species

Species	*Refuge*[1]					*Status*[2]
	Bear Valley	*Clear Lake*	*Lower Klamath*	*Tule Lake*	*Upper Klamath*	
Whitebark pine *(Pinus albicaulis)*	-	U	U	U	-	F: endangered
Slender Orcutt grass *(Orcuttia tenuis)*	-, N	P	U	U	-	F: threatened; CA: endangered
Applegate's milk-vetch *(Astragalus applegatei)*	U	-	P	P	U	F: endangered
Greene's tuctoria *(Tuctoria greenei)*	-	U	U	U	-	F: endangered
Lost River sucker *(Deltistes luxatus)*	U	Y, CH	Y	Y	Y, CH	F: endangered; CA: endangered; OR: endangered
Shortnose sucker *(Chasmistes brevirostris)*	-, N	Y, CH	Y	Y	Y, CH	F: endangered; CA: endangered; OR: endangered
Coho salmon *(Onchorhynchus [=salmo] kisutch)*	-	-	U	U	-	F: threatened; CA: threatened;
Bull trout *(Salvelinus confluentus)*	-	-	-	-	CH	F: threatened; CA: endangered;
Oregon spotted frog *(Rana pretiosa)*	-	-	U	U	P	F: threatened

Table 5.4. Federally Listed and State-Listed Species

Species	*Refuge*[1]					*Status*[2]
	Bear Valley	*Clear Lake*	*Lower Klamath*	*Tule Lake*	*Upper Klamath*	
Canada linx *(Lynx canadensis)*	-	-	U	U	-	F: threatened
North American wolverine *(Gulo gulo luscus)*	-	U	U	U	-	F: proposed threatened; CA: threatened; OR: threatened
Gray wolf *(Canis lupus)*	P	P	Y	Y	P	F: endangered; CA: endangered
Yellow-billed cuckoo *(Coccyzus americanus)*	-	U	U	U	-	F: threatened; CA: endangered
Northern spotted owl *(Strix occidentalis caurina)*	-, N	-, N	U	U	-, Y	F: threatened; CA: candidate; OR: threatened
Bald eagle *(Haliaeetus leucocephalus)*	Y	Y	Y	Y	Y	CA: endangered
Swainson's hawk *(Buteo swainsoni)*	N	N	Y	Y	N	CA: threatened
Great gray owl *(Strix nebulosi)*	N	N	N	N	Y	CA: endangered
Greater sandhill crane *(Grus canadensis)*	N	N	Y	Y	Y	CA: threatened
Bank swallow *(Riparia riparia)*	N	N	Y	N	N	CA: threatened
Willow flycatcher *(Empidonax traillii)*	N	N	N	N	Y	CA: endangered

[1]A "Y" signifies that the species is known to occur within the boundaries of that refuge. An "N" signifies that the species does not occur on the refuge. An "-" signifies that species is not on the official federal species list for that refuge (Appendix S). A "P" signifies that the species potentially occurs on that refuge given the occurrences within the vicinity, but there are no known modern occurrences. A "U" signifies that the species is unlikely to occur on that refuge because there are no known observations and there is no suitable habitat. "CH" signifies that critical habitat has been designated on or adjacent to the refuge.

[2]Listing status of the fish and wildlife species: F = Listed or proposed for listing by the federal government. CA or OR = Listed or candidate by the states of California or Oregon, respectively.

Fishes

Lost River and Shortnose Sucker

Lost River suckers are large fish (up to 3.3 feet long and 9.9 pounds in weight) that are distinguished by their elongate body and subterminal mouth with a deeply notched lower lip. They have dark brown to black backs and brassy sides that fade to yellow or white on the belly. They are native to the Lost River and upper Klamath River systems where they have adapted to lake living (Moyle 2002).

Shortnose suckers are distinguished by their large heads with oblique, terminal mouths with thin but fleshy lips. The lower lips are deeply notched. They are dark on their back and sides and silvery or white on the belly. They can grow to about 23.6 inches, but growth is variable among individuals (Moyle 2002).

The Lost River sucker and shortnose sucker (both federally listed as endangered) are part of a group of suckers that are large, long-lived (Lost River suckers have been aged to 55 years and shortnose suckers to 33 years), and late maturing. They live in lakes and reservoirs but spawn primarily in streams; collectively, they are commonly referred to as lake suckers (NRC 2004). The lake suckers differ from most other suckers in having terminal or subterminal mouths that open more forward than down, an apparent adaptation for feeding on zooplankton rather than sucking food from the substrate (Scoppettone and Vinyard 1991). Zooplanktivory can also be linked to the affinity of these suckers for lakes, which typically have greater abundance of zooplankton than do flowing waters.

Lost River and shortnose suckers spawn from February through May. River spawning habitat is riffles or runs with gravel and cobble substrate, moderate flows, and depths of less than 4 feet (Buettner and Scoppettone 1990). Some Lost River suckers have been noted to spawn in Upper Klamath Lake, particularly at springs occurring along the shorelines. Spawning site fidelity has been documented, suggesting two discrete spawning stocks of Lost River suckers (i.e., those using Upper Klamath Lake springs and Williamson/Sprague Rivers). Lost River and shortnose suckers do not die after spawning and can spawn many times during their lifetime.

Soon after hatching, sucker larvae move out of the gravel. Larvae generally spend relatively little time upriver before drifting downstream to the lakes. Larval habitat is generally along the shoreline, in water 4 to 20 inches deep and associated with emergent aquatic vegetation, such as bulrush (Buettner and Scoppettone 1990; Cooperman and Markle 2000). Emergent vegetation provides cover from predators, protection from currents and turbulence, and abundant prey (including zooplankton, macroinvertebrates, and periphyton).

Juvenile suckers use a wide variety of near-shore habitat including emergent wetlands and non-vegetated areas and off-shore habitat (Burdick et al. 2008; Hendrixson, Burdick, Herring et al. 2007; Hendrixson, Burdkick, Wilkens et al. 2007). As they grow during the summer many move offshore.

Adult suckers generally use water depths 3 feet or deeper (Banish et al. 2007: Peck 2000). Subadults are assumed to be similar to non-spawning adults in their requirements and habitats (NRC 2004). Lost River and shortnose suckers are generally limited to lake habitats when not spawning, although small river-resident populations have been documented.

Lost River and shortnose suckers are endemic to the lakes and tributaries of the upper Klamath Basin. Upper Klamath Lake maintains the largest (by two orders of magnitude) of only two remaining spawning populations of Lost River sucker. It also supports one of the three remaining spawning populations for the shortnose sucker. However, in the past two decades these populations have experienced considerable declines from already significantly decreased numbers. After three consecutive years of massive die-offs of adults in Upper Klamath Lake (1995–1997) both species experienced substantial recruitment into the adult population in 1998. However, by 2001 the populations began once again to decline due to a recurrent unnaturally high rate of juvenile mortality each year, and by 2013 the Lost River sucker population was estimated to be approximately 45% of the 2001 numbers (Hewitt et al. 2015). During the same period the shortnose sucker population declined to only 25% of 2001 levels. Additional populations for these species occur in Clear Lake Reservoir (with shortnose suckers much more prevalent than Lost River suckers), Gerber Reservoir (shortnose sucker only), and Tule Lake Sump 1A (both species, but at very low numbers and with no access to spawning habitat). Spawning does appear to be more consistent for shortnose sucker in Gerber and Clear Lake Reservoirs, but these populations are threatened by persistent introgression with the Klamath largescale sucker (*Catostomus snyderi*).

Critical habitat for the Lost River and shortnose suckers was designated in 2012 (77 *Federal Register* [FR] 73740). The primary constituent elements identified in the proposal are as follows.

(1) **Water**. Areas with sufficient water quantity and depth within lakes, reservoirs, streams, marshes, springs, groundwater sources, and refugia habitats with minimal physical, biological, or chemical impediments to connectivity. Water must have varied depths to accommodate each life stage: Shallow water (up to 3.28 feet [1.0 meter]) for larval life stage, and deeper water (up to 14.8 feet [4.5 meters]) for older life stages. The water quality characteristics should include water temperatures of less than 28.0 degrees Celsius (82.4 degrees Fahrenheit); pH less than 9.75; dissolved oxygen levels greater than 4.0 milligrams per liter; low levels of microcystin; and un-ionized ammonia (less than 0.5 milligram per liter). Elements also include natural flow regimes that provide flows during the appropriate time of year or, if flows are controlled, minimal flow departure from a natural hydrograph.

(2) **Spawning and rearing habitat**. Streams and shoreline springs with gravel and cobble substrate at depths typically less than 4.3 feet (1.3 meters) with adequate stream velocity to allow spawning to occur. Areas containing emergent vegetation adjacent to open water provide habitat for rearing and facilitate growth and survival of suckers, as well as protection from predation and protection from currents and turbulence.

(3) **Food**. Areas that contain an abundant forage base, including a broad array of chironomidae, crustacea, and other aquatic macroinvertebrates.

The two critical habitat units for Lost River sucker are 1) Upper Klamath Lake (includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; Link River; Lake Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam); and 2) Lost River Basin (includes Clear Lake Reservoir and its principal tributary).

The two critical habitat units for the shortnose sucker are 1) Upper Klamath Lake (includes Upper Klamath Lake and Agency Lake, together with some wetland habitat; portions of the Williamson and Sprague Rivers; Link River; Lake Ewauna; and the Klamath River from the outlet of Lake Ewauna downstream to Keno Dam); and 2) Lost River Basin (includes Clear Lake Reservoir and its principal tributary, and Gerber Reservoir and its principal tributaries).

Bull trout, federally listed as threatened, do not occur in Upper Klamath Lake; however, bull trout designated critical habitat is in Upper Klamath Lake itself, on or adjacent to the refuge. This species is not on the official federal species lists for the other refuges (Appendix S).

Coho salmon, federally listed as threatened, is unlikely to occur on Lower Klamath and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This species is not on the official federal species lists for the other refuges (Appendix S). Coho salmon was addressed in a 2013 BiOp (NMFS and Service 2013) and is discussed in Chapter 6.

Amphibians

Oregon spotted frog, federally listed as threatened, potentially occur on Upper Klamath Refuge given occurrences within the vicinity, but there are no known modern occurrences. Oregon spotted frog is unlikely to occur on Lower Klamath and Tule Lake Refuges because there are no known observations and there is no suitable habitat. There is no designated critical habitat within the refuge boundaries. This species is not on the official federal species lists for the other refuges (Appendix S).

Mammals

Canada lynx, federally-listed as threatened, is unlikely to occur on Lower Klamath and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This species is not on the official federal species lists for the other refuges (Appendix S). Therefore, it will not be addressed further in the CCP.

Gray wolf is federally listed as endangered and is known to occur within the boundaries of Lower Klamath and Tule Lake Refuges; and potentially occurs on Clear Lake, Upper Klamath, and Bear Valley Refuges given occurrences within the vicinity, but there are no known modern occurrences.

North American wolverine, federally proposed as threatened, is unlikely to occur on Lower Klamath, Clear Lake, and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This species is not on the official federal species lists for the other refuges (Appendix S). Therefore, it is not addressed further in this CCP.

Birds

Northern Spotted Owl

The northern spotted owl is listed as threatened under the federal ESA. It is also designated as threatened by the State of Oregon and is a species of special concern in California. Northern spotted owls are rare visitors to the Upper Klamath Refuge **and are not on the official species list for that refuge. Northern spotted owl is unlikely to occur on Lower Klamath and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This species is not on the official federal species lists for the other refuges (Appendix S); however, it is listed by the States of California and Oregon.**

Bald Eagle

The bald eagle first gained federal protection in 1940 when Congress passed the Bald Eagle Protection Act. It was later amended to include golden eagles and renamed the Bald and Golden Eagle Protection Act. The species was first listed under the federal ESA on February 14, 1978, when it was designated as endangered throughout the lower 48 states except in Michigan, Minnesota, Wisconsin, and Oregon, where it was designated as threatened (43 FR 6233). The bald eagle was reclassified as threatened in all of the lower 48 states on July 12, 1995 (60 FR 36000).

The Service proposed to remove the species from the List of Endangered and Threatened Wildlife (delist) on July 6, 1999 (64 FR 36454) because they determined that the bald eagle was flourishing across the nation and no longer needed the protection of the federal ESA. It was delisted on August 8, 2007 (72 FR 37346). However, the bald eagle continues to be federally protected under the Bald and Golden Eagle Protection Act. In addition, it is state listed as endangered in California and threatened in Oregon.

Bald eagles generally follow migration corridors between spring/summer and wintering areas in the Pacific Northwest. Eagles leave northern breeding grounds during the fall to seek milder climates. Because of its location, high prey abundance, and relatively mild winter weather, the Upper Klamath Basin supports the largest wintering population of bald eagles in the United States outside of Alaska (Manning and Edge 2002). As many as 985 bald eagles have been counted on the Lower Klamath Refuge in a single day.

In general, bald eagles prefer to roost in trees that are taller and more open in structure than those in the surrounding forest stand (Manning and Edge 2002). In the Upper Klamath Basin, five primary bald eagle communal roosts have been identified (Keister and Anthony 1983), including one at Bear Valley Refuge (for additional information on the Bear Valley communal roost, see Section 5.6).

In most winters, 80% to 90% of the eagles in the basin forage on the Lower Klamath Refuge (Klamath Basin National Wildlife Refuge 2001). The main prey base for wintering bald eagles in the basin is waterfowl and small rodents. During the spring and summer, fish are the primary prey (Frenzel 1985; Frenzel and Anthony 1989).

Since 1984, data indicate a steady and prominent decline in eagle foraging on Tule Lake (Klamath Basin National Wildlife Refuge 1997) that is strongly correlated with a decline in waterfowl use. Concurrently, a shift in waterfowl use to Lower Klamath in both the fall and winter has been recorded. This has been accompanied by a steady increase in the concentration of eagles on Lower Klamath Refuge. By the late 1990s, less than 10% of the eagles in the basin were observed at Tule Lake Refuge (Klamath Basin National Wildlife Refuge 1997). The data clearly indicate that Tule Lake has largely lost its historical role as one of the primary feeding areas for wintering eagles. As a result, the number of traditional feeding areas for the very large concentration of eagles in the region has been reduced from three (Lower Klamath, Tule Lake and Klamath Drainage District lands) to two.

Experimentation with alternate management for Tule Lake has resulted in increased use by both waterfowl and eagles. In 2001, the Sump 1B portion of Tule Lake was de-watered in May and June to promote germination of moist soil food plants for waterfowl and emergent vegetation such as cattail and hardstem bulrush. The area began reflooding in late August with return flows from the Copic Bay area. In September, return flows from the 70,000 acre-feet released from Upper Klamath Lake were also delivered to Tule Lake. Reclamation and Tulelake Irrigation District (TID) directed this water be held in Tule Lake as potential reserve rather than send it to Lower Klamath. The Service and Reclamation have also experimented with an integration of temporary seasonal wetlands (i.e., walking wetlands) into the crop rotations on Tule Lake Refuge federal lease lands (see Habitat/Water Management below). This demonstrated that former croplands could be rapidly restored to productive wetlands habitats that are used by a wide variety of wetland bird species. Waterfowl use of Tule Lake Refuge has increased to levels not seen in approximately 25

years since the inception of rotating seasonal wetlands with cropland (Mauser 2004). Peak eagle use also increased from 10 to 21 in 2001–2002 (Klamath Basin National Wildlife Refuge 2002).

Bald eagle nesting also occurs in the Klamath Basin. Over 30 nesting sites have been recorded within 0.25 mile of Upper Klamath Lake (Service and Reclamation 2006). Nests are built in large trees that are close to open bodies of water, which function as aquatic foraging areas. In Oregon, Douglas-fir and ponderosa pine are the most frequently used species for nest construction (Anthony and Isaacs 1989). In the Upper Klamath Basin, eagles lay eggs as early as mid-February (Manning and Edge 2002). Although it is rare, breeding pairs from two to eight territories, as well as nonbreeding individuals, may forage at Lower Klamath and Tule Lake Refuges during the spring and summer months (Service and Reclamation 2006).

The Klamath Basin also provides summer and winter habitat for non-breeding adult and immature eagles from local populations and from outside the basin and other recovery zones. The number of non-breeding adults and immature bald eagles that use the Klamath Basin in the summer is unknown.

American Peregrine Falcon

The American peregrine falcon was removed from the federal list of threatened and endangered species in the lower 48 states in 1999. It was also removed from the Oregon list of threatened and endangered species in 2007. In California, it is listed as threatened under the California Endangered Species Act, but has been recommended for delisting (California Department of Fish and Game 2008a).

Peregrine falcons are occasionally observed on the covered refuges during the spring and fall waterfowl migration but are not known to breed on the refuges.

Swainson's Hawk

Swainson's hawks are designated as threatened by the State of California and sensitive by the State of Oregon. They typically nest in scattered trees within grassland, shrubland, or agricultural landscapes (e.g., along stream courses or in open woodlands). Swainson's hawks forage in open stands of grass-dominated vegetation, sparse shrublands, and small, open woodlands. In parts of their range, they have adapted well to foraging in agricultural areas (e.g., wheat and alfalfa), but cannot forage in most perennial crops or in annual crops that grow much higher than native grasses (Sidney et al. 1997). Swainson's hawks are rarely observed in the Refuge Complex and are not known to nest on the covered refuges.

Greater Sandhill Crane

The greater sandhill crane is designated as threatened by the State of California and sensitive by the State of Oregon. Greater sandhill cranes are divided into five distinct migratory populations, which return to the same breeding and wintering sites every year (Littlefield and Ivey 2000). These five populations are the Eastern, Prairie, Rocky Mountain, Lower Colorado River Valley, and California Central Valley (Littlefield and Ivey 2000, 2002). The California Central Valley population is found in the Refuge Complex.

There are thought to be an estimated 62,600 greater sandhill cranes in existence today, and approximately 8,500 individuals belong to the California Central Valley population (Littlefield and Ivey 2000). However, an over-wintering population survey for the Central Valley population (conducted in 2000) estimated the total number of birds to be 13,940 (Ivey and Herziger 2001). The most recent breeding surveys have recorded 1,151 breeding pairs in Oregon, 465 breeding pairs in California, 20 pairs in Washington, and 11 pairs in Nevada (Ivey and Herziger 2000, 2001; Littlefield and Ivey 2002). The British Columbia segment is estimated to be approximately 2,500 individuals (Littlefield and Ivey 1994, in Littlefield and Ivey 2002).

The California Central Valley population consists of two groups that breed in different areas. One group winters in the southern part of the California Central Valley and breeds in southeast Washington, southeast and south-central Oregon, northwest Nevada, and northeast California. The other group winters in the northern part of the Central Valley and breeds in British Columbia (Littlefield and Ivey 2002).

Currently, the estimate for greater sandhill cranes (listed as threatened in California) within their Pacific Flyway range is between 5,000 and 6,000 individuals (California Department of Fish and Game 2008b). This species continues to experience threats on both wintering and breeding grounds due to agricultural and urban conversion of habitat, predation, human disturbance, and collisions with power lines.

Within the covered refuges, greater sandhill cranes are primarily found on the Lower Klamath Refuge. The refuge is a fall staging area for 20% to 30% of the Central Valley population.

Great Gray Owl

The great gray owl is designated as endangered by the State of California and sensitive by the State of Oregon. These owls forage in meadows (they are rodent specialists), and nest and roost in nearby dense forest. In the southern part of their range, including Oregon and California, they are found in deciduous or coniferous forests up to 9,186 feet in elevation (Bull and Duncan 1993). The great gray owl is a rare visitor to the Upper Klamath Refuge.

Bank Swallow

Bank swallows (listed as threatened in California) are neotropical migrants that breed in California from April to August and spend the winter months in South America. In California, they are found primarily in riparian and other lowland habitats. The current population is restricted to portions of the upper Sacramento River, primarily between Redding and Colusa, about four or five central and north coast colonies, and scattered colonies in northern and northeastern California including one large population (usually about 1,500 burrows) at Fall River Mills (Schlorff 2000).

Bank swallows are the smallest North American swallow species. They nest colonially and inhabit isolated places where fine-textured or sandy, vertical bluffs or riverbanks are available in which to dig burrows. Bank swallows forage over open riparian areas, brushland, grassland, and cropland. The rip-rapping of the natural stream bank associated with bank protection projects is the single most serious, human-caused threat to the long-term survival of the bank swallow in California (California Department of Fish and Game 2005).

Bank swallows are uncommon spring, summer, and fall visitors to the Lower Klamath Refuge; however, they nest at Lower Klamath Refuge nearly every year.

Willow Flycatcher

The willow flycatcher (California state-listed endangered species and Oregon sensitive species) is a rare to locally uncommon, summer resident in wet meadow and montane riparian habitats at elevations of 2,000 to 8,000 feet in the Sierra Nevada and Cascade Range. Peak fall migration occurs between mid-August and mid-September, and breeding individuals arrive in their breeding territory around late May and early June (Sedgwick 2000).

Willow flycatchers historically nested throughout much of California wherever deciduous shrubs, mainly thickets of willow, occurred (Grinnell and Miller 1944). In the latter half of the twentieth century, the breeding populations drastically declined from lower elevation habitats (Serena 1982). Willow flycatchers have specific habitat requirements, typically consisting of riparian habitat often dominated by willows and/or alder, and permanent water, often in the form of low gradient watercourses, ponds, lakes, wet meadows, marshes, and seeps within and adjacent to forested landscapes. Generally, throughout the range of the willow flycatcher, historic wet meadow habitats have been drained for agriculture purposes and a percentage converted to crop production. More recently, predators and brood parasitism have been discovered to negatively influence survival and reproduction (Green et al. 2003).

Willow flycatchers are uncommon spring, summer, and fall visitors to the Upper Klamath Refuge.

Yellow-billed cuckoo

Yellow-billed cuckoo, federally listed as threatened, is unlikely to occur on Lower Klamath, Clear Lake, and Tule Lake Refuges because there are no known observations and there is no suitable habitat. This species is not on the official federal species lists for the other refuges (Appendix S). Therefore, it is not addressed further in this CCP.

Invasive/Non-Native Wildlife Species

Invasive and exotic species have been called "the greatest threat to ecosystem integrity within the Refuge System" (Service 2004a). Invasive species can threaten the diversity or abundance of native species through competition for resources, predation, parasitism, interbreeding with native populations, transmitting diseases, or causing physical or chemical changes to the invaded habitat.

Invasive Fish

In the last century, the Upper Klamath Basin has been invaded by 17 nonnative species, 15 of which were introduced for sport fishing or for bait (NRC 2004). One of the most recent invaders is the fathead minnow, which is now one of the most abundant fishes in Upper Klamath Lake (Simon and Markle 1997). The Sacramento perch was introduced into Clear Lake in the 1960s and has spread throughout the Lost River and into the Klamath River downstream to Iron Gate Reservoir (Buettner and Scoppettone 1991). Other introduced species that occur in the Refuge Complex include the brown bullhead, Sacramento perch, green sunfish, bluegill, pumpkinseed, largemouth bass, white crappie, black crappie, and yellow perch.

Invasive Amphibians

The bullfrog is the largest frog in North America and is native to eastern North America. Bullfrogs were first introduced to Oregon in the 1920s to provide frog legs for the West Coast market. The frog leg industry declined in the 1930s, but the bullfrogs remain (ODFW undated). The bullfrog is highly adaptable to a number of aquatic habitats and is an opportunist that will eat anything it can catch and swallow.

In Oregon, areas with an abundance of bullfrogs have few or no turtle hatchlings or other frog species (ODFW undated). This same pattern occurs between bullfrogs and other amphibian and reptile species in several other western states where the bullfrog has been introduced (ODFW undated).

Invasive Invertebrates

No populations of invasive invertebrates are known to occur in the Refuge Complex at this time. Specific monitoring for these types of invasive species has not been completed. Potential future invasive species may include species like quagga mussel or zebra mussels.

5.1.3 Cultural Resources

In May 2011, a cultural resources assessment was prepared for the five refuges addressed in this CCP (Service 2011a) (Appendix O). More detailed cultural resources information is provided in this chapter within the sections addressing each refuge (Sections 5.2 through 5.6).

5.1.4 Facilities

There are a number of structures located on the covered refuges. These structures include shops, vehicle storage, offices, residences, fueling stations, pump houses, hazardous material storage, visitor centers, and wildlife rehabilitation buildings. Most of the heavy equipment and other refuge equipment and vehicles are parked in common areas at Tule Lake and Lower Klamath Refuges. Routine maintenance activities of refuge equipment occur in these areas. Hazardous material storage buildings are located at each refuge facility. Herbicides, pesticides, cleaning chemicals, paint, and petroleum products are the most common hazardous materials used on the refuges.

5.1.5 Visitor Services

<u>Visitor Services and Management Policy</u>

There are a variety of sources for policy and guidance to manage public use programs in the Refuge Complex. The Service Manual (605 FW 1-7) provides the policy for wildlife-dependent recreation including hunting, recreational fishing, wildlife observation, wildlife photography, environmental education, and interpretation. The policy also provides guiding principles for each of the wildlife-dependent recreation programs.

Trends

The ability to compare and analyze population and demographic trends is invaluable in making projections about future recreational needs, as well as assessing existing visitor facilities and programs. The following are highlights of some recreation reports and surveys that are available for consideration when managing the visitor services program.

The *Public Opinions and Attitudes on Recreation in California* report (California Department of Parks and Recreation 2003) and the *Oregon Statewide Comprehensive Outdoor Recreation Plan 2003-2007* (Oregon Parks and Recreation Department 2003) summarize surveyed public attitudes, opinions, and values regarding key areas of interest relating to outdoor recreation opportunities in California and Oregon and public participation interests in different types of outdoor recreation activities.

In California, the results of the study conducted on the public opinions and attitudes about outdoor recreation are in general agreement with past editions of this study. Californians think outdoor recreation areas and facilities are very important to their quality of life (84.1%), and more than two-thirds (69.1%) reported spending the same or more time in outdoor recreation activities than 5 years ago. Almost all Californians (96.7%) agreed or strongly agreed that maintaining the natural environment in outdoor recreation areas was important to them. The most important factors influencing enjoyment of recreational activities were being able to relax (75.9%), feeling safe and secure (68.3%), being in the outdoors (75.9%), and beauty of the area (61.8%); meeting new people (13.2%) ranked last.

Recreational activities, including three priority wildlife-dependent activities, were surveyed and ranked (Table 5.5), although it should be noted that the nature study category could also include educational and interpretive activities. Walking for fitness and fun was ranked number one with 91.1% participating in an average 94.4 days per year. Driving for pleasure and sightseeing, and driving through natural scenery, ranked second at 90.2% (31.3 days). Windsurfing showed the lowest percentage of participation (3.4%), with snowmobiling and orienteering/geo-caching tied for next lowest (4.6%). Fifty percent or more of the respondents participated in 11 of the 55 recreation activities at least 1 day during the 12 months prior to the survey.

Table 5.5. Ranking of Three Wildlife-Dependent Activities

	Rank	*Participation (%)*	*Average Number of Days Participated*
Wildlife viewing, bird watching, viewing natural scenery	8	75.1	**25.3**
Fishing (freshwater)	19	34.0	**5.8**
Hunting	49	9.0	**1.9**

Source: California Department of Parks and Recreation (2003)

In Oregon, the results of the Oregon Outdoor Survey, conducted over a 1-year period from February 2001 to January 2002, showed that Oregonians are actively engaged in all types of outdoor recreation activities in the state. About 73% of Oregon households had participated in outdoor recreation activities within the past 12 months. The most popular everyday activities were running and walking for exercise and walking for pleasure (Table 5.6). Bird watching was ranked third and nature/wildlife observation was ranked fourth.

Table 5.6. Top Ten Oregon Outdoor Recreation Activities - State Residents

Activity	*Estimated Annual User Days* (millions)*
Running/walking for exercise	49.2
Walking for pleasure	47.7
Bird watching	18.7
Nature/wildlife observation	17.6
Sightseeing/driving for pleasure	12.3
RV/trailer camping	11.0
Golf	9.6
Using park playground equipment	8.8
Bicycling	7.4
Ocean beach activities	6.0

* A user day is one instance of participation in a single outdoor recreation: Oregon Parks and Recreation Department (2003)

The *Park and Recreation Trends in California 2005* report summarizes the state's population and demographic trends affecting parks, recreation areas, programs, and services (California State Parks 2005). Listed below are some of the highlights from the 2005 report.

- California's population is currently 34 million and will increase by 0.5 million persons annually
- California is continuing to be more culturally and racially diverse—Asians and Hispanics are the top two groups
- California's senior population will double by 2010
- Baby boomers (40–60 years) are reaching retirement age, adding to the citizen-steward group
- Today's youth (18–40 years) are the most urban of any generation, seeking 1-day excursions with multiple activities
- Understanding how people recreate will be the most effective way to serve visitors
- California's advanced technology and transportation will expand recreational opportunities
- Favorite outdoor recreation activities, pertinent to refuges, that will continue to dominate include walking, picnicking, sightseeing, and visiting nature centers
- Day hiking, bicycling, running, and wildlife viewing are predicted to increase in popularity
- Educational and interpretive programs will continue to be essential to help visitors understand the relationship between humans, nature, and cultural heritage.

The *Oregon Statewide Comprehensive Outdoor Recreation Plan 2003-2007* (Oregon Parks and Recreation Department 2003) summarizes the state's population, demographic, and public provider trends affecting parks, recreation areas, programs, and services. Listed below are some of the highlights.

- Oregon's population is rapidly increasing
- Diversity is rapidly increasing within the population
- A growing gap between the rich and the poor
- The state's population is increasingly urban
- The public is asking land managers to place an increasing emphasis on the protection of streams, fish, wildlife habitat, and threatened and endangered species
- The public is asking land managers to manage for amenities including quiet, natural places, natural-appearing settings, and information and education

- The recreation public has less disposable leisure time available than in the past. As a result, they are taking shorter trips involving closer to home travel
- As more of the "baby boomer" generation retires, the demand for recreation facilities with high amenities and accessibility is likely to increase
- Rural communities are becoming increasingly interested in collaborating with managers and recreation providers on developing opportunities that have the potential of diversifying their economies, while still maintaining their quality-of-life values
- Nature study activities are rising in popularity
- In some areas in the near future, water may be more valuable for recreation than for agriculture
- Managing for conflicts between recreational users seems to be an increasing need as demand for limited space increases and supply decreases.

Recreation trends in the United States are found in *Outdoor Recreation in American Life: A National Assessment of Demand and Supply Trends* (Cordell et al. 1999). Projections were made nationally for four U.S. regions, with California and Oregon included in the Pacific Coast region. Trends for the Pacific Coast region indicate wildlife viewing and nature study are expected to increase by 65% and double the number of days per year per person in the next 40 years. Fishing is expected to increase, while hunting is expected to decrease.

The *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (Survey) (Service, U.S. Department of Commerce, and U.S. Census Bureau 2006) is a comprehensive publication that provides information about the numbers of U.S. anglers, hunters, and wildlife-watchers by state. The Survey found that 7.4 million California residents and nonresidents 16 years and older fished, hunted, or watched wildlife in California. Of the total participants, 1.7 million fished, 281 thousand hunted, and 6.3 million participated in wildlife-watching activities spending a total of $8.0 billion on wildlife recreation in California. When compared to the 1996 Survey (Service, U.S. Department of Commerce, and U.S. Census Bureau 1996), the number of anglers decreased by 36%, number of hunters decreased by 45%, and wildlife-watching (away from home) increased by 23%.

The Survey found that 2.3 million Oregon residents and nonresidents 16 years and older fished, hunted, or watched wildlife in Oregon. Of the total participants, 576,000 fished, 237,000 hunted, and 1.5 million participated in wildlife-watching activities spending a total of $2.0 billion on wildlife recreation in Oregon. When compared to the 1996 Survey (Service, U.S. Department of Commerce, and U.S. Census Bureau 1996), the number of anglers decreased by 12%, number of hunters decreased by 19%, and wildlife-watching (away from home) increased by 110%.

Hunting and Fishing

Only geese, ducks (including mergansers), American coots, common moorhens, and Wilson's snipe may be hunted on the Lower Klamath, Tule Lake, Upper Klamath, and Clear Lake Refuges. At Lower Klamath and Tule Lake Refuges, in addition to the aforementioned waterfowl, pheasant hunting is also allowed. Limited pronghorn hunting is allowed on Clear Lake Refuge. Limited deer hunting is allowed on the Bear Valley Refuge. All hunters must carry valid state hunting licenses and all required state and federal stamps and permits. Fishing is permitted in designated areas of Upper Klamath Refuge in accordance with state and federal regulations.

On Tule Lake and Lower Klamath Refuges, during the first two days of waterfowl season, all hunters 16 years of age or older must carry a valid entry permit for the controlled unit in which

they are hunting. Hunters under the age of 16 must be accompanied by a permitted adult. Permits are issued in advance of waterfowl season to applicants selected by a lottery draw. A yearly hunt fee is required to hunt Tule Lake and Lower Klamath Refuges. Two duck hunting blinds for users with permanent mobility impairments are located in marsh units of Lower Klamath Refuge. Mobility-impaired hunters with current disabled parking permits are eligible to use these blinds. To qualify for blinds for mobility-impaired hunters, the hunter must possess one of the following: 1) a state Department of Motor Vehicles disabled license plate or a disabled veteran license plate, 2) a permanent parking placard identification card, or 3) a mobility-impaired person's motor vehicle hunting license.

Four spaced-blinds for users with permanent mobility impairments are located on Tule Lake Refuge. These goose-hunting blinds are available in a drawing, which is conducted each morning prior to the regular spaced-blind drawing. All waterfowl field hunt areas of Tule Lake Refuge are open to drive-in access. This allows hunters with disabilities to access all hunt fields.

Hunting is permitted 7 days per week during the state regulated season. Legal waterfowl shooting hours end at 1:00 p.m. on the Tule Lake Refuge and the California portion of Lower Klamath Refuge. Waterfowl shooting hours for the Oregon portion of Lower Klamath correspond to state regulations. Pheasant hunting hours on all refuge areas correspond to state regulations.

The Refuge Complex also conducts special youth hunting programs. These hunts are held on both the California and Oregon portions of the Refuge Complex. Youth hunts are open for youths (15 and under) to hunt ducks and geese. Only licensed youth hunters are allowed to carry firearms in the field.

Because of the differences in location, size, habitat, and wildlife present at each of the refuges, hunting opportunities are different and are therefore discussed below in the sections addressing conditions at each refuge (Sections 5.2 through 5.6).

Wildlife Observation and Photography

The Refuge Complex offers excellent, year-round wildlife observation opportunities. Automobile tour routes are available at both Tule Lake Refuge and Lower Klamath Refuge. Self-guided canoe trails are provided at Tule Lake and Upper Klamath Lake. Exceptional viewing of early morning fly-outs of large numbers of bald eagles from their winter roost at Bear Valley Refuge is available from a location outside the refuge.

All of the refuges in the Refuge Complex are also part of the Klamath Basin Birding Trail, which is approximately 300 miles long and features 47 birding sites.

Environmental Education

The Refuge Complex headquarters and visitor center (located on Hill Road, 5 miles west of Tulelake, California) offers a variety of exhibits, nature collections, and mounted wildlife. Complementary brochures, posters, and leaflets regarding the National Wildlife Refuge System (NWRS) are also available. In addition, refuge staff conducts presentations and tours upon request both on and off the refuges.

Interpretation and Outreach

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. First-hand experience with the environment is emphasized although presentations, audiovisual media, and exhibits are often necessary components of the interpretive program.

At the refuge headquarters and visitor center, Tule Lake Refuge wildlife is colorfully described by exhibits, and information regarding viewing opportunities, recent sightings, road conditions, and regulations is available. A non-profit bookstore offers wildlife-oriented books and other items.

Interpretive trails are also available at Tule Lake Refuge. Trailside exhibits provide interpretation of the area's natural and cultural histories. A 0.3-mile foot trail near the visitor center provides a spectacular view of the surrounding area and an interpretative leaflet is available at the trailhead. Also near the visitor center is Discovery Marsh, which allows for up close investigations of a marsh. Interpretive wayside exhibits demonstrate wetland management and wildlife.

Refuge related information is also provided at annual local festivals or during special events, such as the Winter Wings Festival. The festival is produced by the Klamath Basin Audubon Society and is considered the longest running bird festival in the nation. It includes local experts and national recognized leaders and speakers in workshops, field trips, mini-sessions, vendors, live birds, special events, and displays that appeal to families and junior naturalists.

Volunteer Program

The National Wildlife Refuge System Volunteer and Partnership Enhancement Act of 1998 (PL 105-242) strengthens the role of the NWRS in developing relationships with volunteers. Volunteers possess knowledge, skills, and abilities that can enhance the scope of refuge operations. Volunteers enrich refuge staff with their gift of time, skills, and energy. Refuge staff will initiate, support, and nurture relationships with volunteers so that they may continue to be an integral part of refuge programs and management. The volunteer program is managed in accordance with the Service Manual, Part 150, Chapters 1 through 3, "Volunteer Services Program," and Part 240 Chapter 9 "Occupational Safety and Health, Volunteer and Youth Program."

Safety

Safety is important for the Refuge Complex staff and for visitors. Quarterly staff safety meetings are held at the Refuge Complex headquarters. The intent of the meetings is to update and train personnel, as well as to resolve any safety concerns that arise.

5.1.6 Partnerships

In *Fulfilling the Promise: The National Wildlife Refuge System* (Service 1999) the Service identified the need to forge new and non-traditional alliances and strengthen existing partnerships with states, tribes, non-profit organizations, and academia to broaden citizen and community understanding of and support for the NWRS. The Service recognizes that strong citizen support benefits the NWRS. Involving citizen groups in refuge resource and management issues and

decisions helps managers gain an understanding of public concerns. Partners yield support for refuge activities and programs, raise funds for projects, act as advocates for wildlife and the NWRS, and provide support on important wildlife and natural resource issues.

A variety of people, including but not limited to scientists, birders, anglers, hunters, farmers, outdoor enthusiasts, and students are keenly interested in the management of the Refuge Complex, its fish and wildlife species, and its plants and habitats; this is illustrated by the partnerships that have already developed, including the following.

- The Klamath Tribes
- Oregon Department of Fish and Wildlife
- California Department of Fish and Wildlife
- U.S. Forest Service
- Adjacent private land owners
- U.S. Geological Survey
- The Nature Conservancy
- Klamath Bird Observatory
- Local school districts
- Volunteers and Friends Groups
- Klamath County Audubon Society

New partnerships will continue to be formed with interested organizations; local civic groups; community schools; federal, state, and county governments; tribes; and other civic organizations. Additionally, refuge staff is available to provide technical assistance and education and outreach information to landowners who are interested in conserving fish and wildlife habitats on their lands.

5.1.7 Law Enforcement and Resource Protection

The staff of the Refuge Complex recognizes the obligation that has been entrusted to them—the care of valuable natural and cultural resources—and they take this responsibility very seriously.

Law enforcement on the refuges is used both for protection and for prevention. Used for prevention, law enforcement safeguards the visiting public, staff, facilities, and natural and cultural resources from criminal action, accidents, vandalism, and negligence. Used as prevention, law enforcement inhibits incidents from occurring by providing a law enforcement presence. The Refuge Complex has one full-time law enforcement officer.

5.1.8 Social and Economic Conditions

<u>Regional Economic Conditions</u>

The Refuge Complex study area is in a rural area with few nearby communities. Klamath Falls, Oregon, is the largest city near the Refuge Complex, with an estimated 2010 population of more than 20,000 (U.S. Census Bureau 2010). Among study area communities, Klamath Falls provides the greatest array of amenities (e.g., hotels, restaurants, retail stores) for visitors to the region. Some of the smaller communities in the study area, such as Tulelake and Dorris, also provide visitor amenities, such as motels, restaurants, and gas stations. Tulelake is a town of 1,010 residents located on State Route 139 in California, just east of the Tule Lake and Lower Klamath Refuges and west of Clear Lake Refuge. The town of Dorris, located in California along U.S. 97

west of Lower Klamath Refuge, had an estimated population of 939 in 2010. Communities in Oregon near the Refuge Complex include Chiloquin (population 734 in 2010), located east of the Upper Klamath Refuge; Merrill (population 844 in 2010), located north of Tule Lake and Lower Klamath Refuges; and Malin (population 805 in 2010), located east of Merrill.

Refuge operations contribute to levels of industry output, employment, and personal income in the study region. The sectors of the study area's economy that most benefit from refuge operations include the agricultural sector, the federal government sector, and various related sectors that collectively comprise the recreation and tourist-servicing industry, including food and beverage stores, gasoline stations, miscellaneous retailers, hotels and motels, and food services and drinking establishments. Industry output represents the dollar value of an industry's total production. Value of production is usually measured as the market value of goods and services sold by an industry. Employment is the number of jobs in each industry, including both full- and part-time workers and self-employed individuals. Personal income mostly consists of the wages, salaries, and value of benefits of the affected work force.

Economic activity of the directly affected sectors also indirectly affects economic conditions in other sectors of the study area's economy as spending in the directly affected businesses and the government, and its employees, ripple through the study area economy. For this analysis, economic conditions in the study area are characterized by levels of industry output (value of total production), jobs, and personal income in 2010.

As shown in Table 5.7, economic output in the study area totaled about $6.8 billion in 2010, with Oregon's Klamath County generating the largest shares of output, followed by Siskiyou and Modoc Counties in California. Considered together, the three major sectors most sensitive to refuge management and operations—agriculture, recreation and tourist servicing, and federal government—accounted for about 24% of total industry output in the study area in 2010.

The number of jobs and levels of personal income are key indicators of the importance of these sectors to the study area economy. As derived from data in Tables 5.8 and 5.9, the three major sectors considered most sensitive to refuge management (agriculture, federal government, and various sectors that collectively comprise the recreation and tourist-servicing industry) accounted for about 28% of the jobs and 24% of the personal income in the study area in 2010. Agriculture accounted for about 7% of total employment and 3% of personal income in the study area, with Klamath and Siskiyou Counties accounting for most of the agricultural employment and income. Federal government employment generated about 3% of study area employment, but nearly 10% the area's employee compensation in 2010, with Siskiyou County accounting for the largest share.

The sectors comprising the recreation and tourist-servicing industry (including food and beverage stores, gasoline stations, retail businesses, hotels and motels, and food services and drinking establishments) accounted for about 18% of study area-wide employment and 11% of personal income, with more than half of the retail employment and income located in Klamath County.

Estimates of the contribution that the five refuges make to the three-county regional economy are identified below in the Contribution to the Regional Economy of Existing Refuge Complex Operations, Refuge Visitor-Related Spending, and Agricultural Production on Refuge Complex Lands sections.

Refuge Complex Administration

Refuge Complex facilities include shops, vehicle storage, offices, residences, fueling stations, pump houses, hazardous material storage, visitor centers, and wildlife rehabilitation buildings. These facilities support refuge maintenance and management activities and operations, as well as visitor services. The Refuge Complex administrative headquarters and visitor center are located at the northwest corner of Tule Lake Refuge, near the community of Tulelake in Siskiyou County. Most of the heavy equipment and other refuge equipment and vehicles are parked in common areas at Tule Lake and Lower Klamath refuges. Routine maintenance activities of refuge equipment occur in these areas.

During the last (2014–2015) fiscal year, the Service spent $3,939,570 to operate and maintain the five refuges, including $3,040,767 for salaries, and $898,803 for all other expenses. As part of base budget expenditures, the Service spends about 3 million dollars on salaries, employing 27 employees who assist with management, operations, and maintenance of the four refuges being analyzed in the Refuge Complex and its programs. All of the employees reside in the study area, with most of the administrative staff living within 30 miles of the administration/operations headquarters near the community of Tulelake (Siskiyou County). Although not presented in Table 5.10, base goods and services expenditures across the three budgets generally fall into the following categories: utilities (25%), fuel (23%), vehicle and equipment replacement (20%), vehicle repair (18%), parts and building materials (9%), and office supplies (5%).

Visitor Use

Based on spending profiles for local (within 50 miles) and non-local residents who visited the Refuge Complex, as reported in the *2006 National Survey of Fishing, Hunting and Wildlife-Associated Recreation* (Service et al. 2006), total visitor-related expenditures made within the three-county study area were estimated. Annual spending in the study area by visitors to the Reclamation Complex is estimated at $4,225,000 (2015 dollars). Of this total, spending in food and drink establishments and for transportation (excluding air transport) each accounted for about 31% of total regional spending, and lodging expenditures accounted for about 24%. Non-local visitors accounted for an estimated 63% of total visitor-related spending within the study region.

Agricultural Production on Refuge Complex Lands

Agricultural production within the Refuge Complex is limited to properties within the Lower Klamath and Tule Lake Refuges. Within the two refuges, properties are farmed under both the lease land and cooperative farming programs. The lease land program is managed by the Reclamation under an agreement with the Service (Appendix R), and the Service manages the cooperative farming program.

Table 5.7. Total Economic Output[a] by Industry in Study Area Counties 2010 (millions of 2015 dollars)

	Industry Category								
County	*Agriculture*[a]	*Food and Beverage Stores*	*Gasoline Stations*	*Miscellaneous Retailers*[b]	*Hotels and Motels*[c]	*Food Services and Drinking Establishments*	*Federal Government*[d]	*All Other Sectors*	*Total*[e]
Klamath (Oregon)	237	38	21	181	32	103	73	2,818	**3,502**
Modoc (California)	161	6	7	15	1	8	37	322	**557**
Siskiyou (California)	304	30	44	90	38	77	96	2,053	**2,734**
TOTAL[e]	702	74	72	287	71	189	206	5,194	**6,794**

Source: Minnesota IMPLAN Group 2010 base data, ran in 2012.

Notes:

[a] Includes crop, cattle and livestock, dairy, milk production, poultry and egg production, nursery and floriculture production, and agricultural and forestry support services sectors.

[b] Includes retailers, excluding food and beverage stores and gasoline stations.

[c] Also includes other types of accommodations.

[d] Excludes federal enterprises and military and U.S. Postal Service sectors.

[e] Totals may differ from the summation of components due to rounding.

Table 5.8. Total Employment[a] by Industry in Study Area Counties, 2010

				Industry Category					
County	*Agriculture*[b]	*Food and Beverage Stores*	*Gasoline Stations*	*Miscellaneous Retailers*[c]	*Hotels and Motels*[d]	*Food Services and Drinking Establishments*	*Federal Government*[e]	*All Other Sectors*	*Total*[f]
Klamath (Oregon)	1,842	625	276	2,905	369	1,844	696	23,675	**32,232**
Modoc (California)	679	96	32	223	9	154	359	2,906	**4,458**
Siskiyou (California)	1,550	470	268	1,304	398	1,307	946	15,235	**21,478**
TOTAL[f]	**4,071**	**1,191**	**576**	**4,432**	**776**	**3,305**	**2,001**	**41,816**	**58,168**

Source: Minnesota IMPLAN Group 2010 base data, ran in 2012.

Notes:

[a] Includes full- and part-time jobs.

[b] Includes crop, cattle and livestock, dairy, milk production, poultry and egg production, nursery and floriculture production, and agricultural and forestry support services sectors.

[c] Includes retailers, excluding food and beverage stores and gasoline stations.

[d] Also includes other types of accommodations.

[e] Excludes federal enterprises and military and U.S. Postal Service sectors.

[f] Totals may differ from the summation of components due to rounding.

Table 5.9. Total Personal Income Compensation[a] by Industry in Study Area Counties 2010 (millions of 2015 dollars)

	Industry Category								
County	*Agriculture[b]*	*Food and Beverage Stores*	*Gasoline Stations*	*Miscellaneous Retail[c]*	*Hotels and Motels[d]*	*Food Services and Drinking Establishments*	*Federal Government[e]*	*All Other Sectors*	*Tota[f]*
Klamath (Oregon)	25.3	17.2	6.5	67.4	7.4	30.3	65.6	860.5	1080.2
Modoc (California)	11.2	2.2	0.1	5.1	0.1	2.0	32.4	86.9	140.0
Siskiyou (California)	20.0	12.9	6.1	29.0	6.6	20.0	84.7	504.1	683.5
TOTAL [f]	56.5	32.3	12.7	101.5	14.1	52.3	182.7	1451.6	1903.7

Source: Minnesota IMPLAN Group 2010 base data, ran in 2012.

Notes:

[a] Includes wages, salary, and value of benefits of employees (employee compensation); excludes proprietary income and other property-type income.

[b] Includes crop, cattle and livestock, dairy, milk production, poultry and egg production, nursery and floriculture production, and agricultural and forestry support services sectors.

[c] Includes retailers, excluding food and beverage stores and gasoline stations.

[d] Also includes other types of accommodations.

[e] Excludes federal enterprises and military and U.S. Postal Service sectors.

[f]Totals may differ from the summation of components due to rounding.

Table 5.10. Estimated Fiscal Year 2014–2015 Budget Expenditures (2015 dollars) and Other Data for the Klamath Basin National Wildlife Refuge Complex

Category	*Lower Klamath Refuge*	*Clear Lake Refuge*	*Tule Lake Refuge*	*Bear Valley Refuge*	*Upper Klamath Refuge*	*Five Refuge Total*
Salary Expenditures	$1,364,508	$303,224	$1,061,284	$151,612	$160,138	$3,040,767
All Other Expenditures	$404,461	$89,880	$314,581	$44,940	$44,940	$898,803
Total Budget	***$1,768,970***	***$393,104***	***$1,375,865***	***$196,552***	***$205,078***	***$3,939,570***
RSS Transfers[a]	$11,947	$8,095	$19	$6,409	$19,927	$14,523
Kuchel Act PILT Payment	-	-	-	-	-	$10,696
Number of Jobs	-	-	-	-	-	27

Source: Griggs pers. comm.

Notes:

[a] RSS transfer data is from 2014 and indexed to 2015 dollars.

Approximately 5,600 acres of land on the Lower Klamath Refuge and 14,900 acres of land on the Tule Lake Refuge were leased and farmed in accordance with the Kuchel Act in 2015 (Pelz pers. comm.). Leases are awarded in 5-year increments with the option to renew each year. Approximately 20% of the leases are put out for bid each year with the remaining available for renewal. Although up to 25% of lease land areas may be planted to row crops, the lease lands within the two refuges are currently used by local growers for the commercial production of conventional and organic alfalfa, grass hay, potato, onion, horseradish, and small grains, and for livestock grazing. The lease land program has generated an average of $3.6 million annually in lease revenue from 2006 through 2015, which is retained by Reclamation (Green pers. comm.).

Acreage farmed on the two refuges under the Cooperative Farmland Program are dedicated exclusively to cereal grain (usually barley) production on the Lower Klamath Refuge and grains, potatoes, and onions on the Tule Lake Refuge. The farmer is allowed to harvest three-quarters of the crop in consideration of his expense and labor for tilling, seeding, and fertilizing the crop. The one-fourth that the farmer is not allowed to harvest is left standing in the field for the benefit of wildlife. The farmer provides all seed, fertilizer, pesticide, equipment, fuel, and labor while the Service provides the land, water, and irrigation services. Approximately 2,400 acres of land on the Tule Lake Refuge, and 4,500 to 5,000 acres of land on the Lower Klamath Refuge, were cooperatively farmed in 2011 through 2015 (Barry pers. comm.).

Combining both programs, agricultural areas in the two refuges totaled approximately 27,900 acres in 2015, including 10,000 acres within the Lower Klamath Refuge and 17,900 in the Tule Lake Refuge (Table 5.11). Based on the average yields and prices shown in Table 5.11, the value of production on harvested acreage totaled an estimated $32.3 million in that year, including approximately $6.0 million on Lower Klamath Refuge properties and $26.3 million on Tule Lake Refuge properties. As discussed previously, a portion of this annual gross production income received by farmers is paid to Reclamation through the Lease Land Program.

Table 5.11. Agricultural and Crops Productivity (2015 dollars)

Category	*Crops*	*Yield per Acre*	*Value per Unit*	*Average Group Yield per Acre*[a]	*Average Group Value per Unit*[b]	*Average Sales per Acre*
Alfalfa	Alfalfa (ton)	5.25	$186	5.25	$186	$976
Grains	Barley (ton)	2.75	$222	2.6175	$238	$623
	Oats (ton)	2.47	$261			
	Rye (ton)	1.95	$214			
	Wheat (ton)	3.3	$255			
Hay	Hay (ton)	4.1	$148	4.1	$148	$606
Row Crops	Onions (cwt)	503	$6.84	508	$7.88	$4,003
	Potatoes (cwt)	513	$8.92			

Notes:
[a] Represents average yield per acre in Siskiyou County from 2007 to 2011, as reported in annual Siskiyou County crop and livestock reports.
[b] Represents average gross value of production per unit from 2007 to 2011, as reported in annual Siskiyou County crop and livestock reports.

5.1.9 Management and Monitoring Practices

Habitat/Water Management

General habitat management practices common to two or more of the refuges in the Refuge Complex are described below. Additional details concerning habitat management practices specific to individual refuges are presented in Sections 5.2 through 5.6.

Lease Lands

Congress passed the Kuchel Act (PL 567-88) in 1964, with legislation intended to ensure that certain refuge habitats are preserved for migratory waterfowl but allow for continued agricultural practices consistent with waterfowl conservation. A portion of land on the Tule Lake Refuge and Lower Klamath Refuge is farmed in accordance with the Kuchel Act. Although the lease lands are under the administrative jurisdiction of the Refuge Complex, Reclamation administers the agricultural leasing program via a Cooperative Agreement (Appendix R), including pesticide use, for the Refuge Complex consistent with the Kuchel Act (PL 88-567).

The lease lands are located in Klamath County, Oregon, and Siskiyou and Modoc Counties, California. They comprise an area of about 16,000 acres on Tule Lake Refuge and 6,000 acres on Lower Klamath Refuge. The lease lands are used by local growers currently for the commercial production of conventional and organic alfalfa, grass hay, potato, onion, and small grains. Leases are awarded in 5-year increments with the option to renew each year. Approximately 20% of the leases are put out for bid each year with the remaining approximately 80% available for renewal. In accordance with the Kuchel Act, approximately 25% of net lease revenues are shared with local counties as a payment in lieu of taxes.

Walking Wetlands

As described above, when enacted in 1964, the Kuchel Act sought to maintain the wetland wildlife values of the refuges while simultaneously maintaining a 22,000-acre lease land farming program. Over the last several decades interpretation of the Kuchel Act has become increasingly controversial and the focus of several lawsuits. Settlement of these lawsuits resulted in very little change in refuge operations or improvements in wildlife habitat. Instead, litigation tended to further polarize refuge stakeholders. In the early 1990s, the Service realized that new strategies for managing these seemingly conflicting land uses needed to be developed. Decades of stabilized water levels reduced wetland productivity and diversity, and continuous farming had increased the need for expensive crop inputs to maintain yields. Innovative management strategies may be found whereby wetlands and agricultural lands could be integrated in ways that maintain ecological integrity, as well as the economic well-being and sustainability of surrounding rural communities. Benefits of such a program could extend far beyond the refuges and the larger Klamath Basin.

In the 1990s, the Service and its partners began seeking answers to these questions by initiating a program of experimental rotation of wetlands (termed “walking wetlands”) within commercial farm fields on both the Tule Lake and Lower Klamath Refuges. Not surprisingly, these newly restored wetlands supported a large number and diversity of waterfowl and other waterbirds. However, what surprised both farmers and agency personnel was that wetlands had substantial benefits to agriculture as well. Research and reports from individual farmers indicated that

wetland rotations eliminated the need for soil fumigation (to control nematode pests) and some fertilizers at a cost savings of more than $200/acre. In addition, crop yields increased by approximately 25%. The improved agricultural productivity of the lands was quickly reflected in an increase in lease revenues to the federal government.

Due to demonstrated success on refuge agricultural lands, several farmers adjacent to both Tule Lake Refuge and Lower Klamath Refuge expressed interest in incorporating wetlands into their farming operations. Private lands, however, provided a unique challenge. On the refuges, farm fields are converted to wetlands when farm leases or sharecrop agreements expire. In contrast, a grower on private lands can seldom afford to take land out of production for even a single year. To solve this dilemma, the Service is compensating farmers with croplands, from a relatively small area of crop share fields on the refuge, which are already farmed for wildlife purposes, in return for an equal acreage of wetlands on private lands. The net result is more wetlands and wildlife habitat created in the Klamath Basin, and less reliance on fertilizers and pesticides in crop production. Both wildlife and rural farm economies benefit from this strategy.

The duration of flooding and the hydrology of the wetlands vary from 1 to 4 years and are managed as either seasonally flooded (fall through spring) or on a year-round basis. Fields are typically first flooded as soon after harvest as possible and are used almost immediately by fall migrant waterfowl and sandhill cranes, as well as wintering raptors including large numbers of bald eagles. Following the wetland cycling, fields are returned to agricultural production. Waterbird use of flooded fields has been represented by a diversity of species including many that are considered “sensitive” by the State of California.

Fire Management

The Refuge Complex has had a fire management staff since 1988. However, it was not until 1990 that a dedicated Fire Management Officer was placed at refuge headquarters. The primary responsibilities of the fire management staff are to provide initial attack fire suppression capability on the Refuge Complex, conduct hazard fuels reduction projects, provide interagency support in fire suppression, and conduct prescribed burns in support of refuge habitat and water management programs (Service 2007a).

Klamath Basin hosts two engine modules servicing the interagency areas dispatched by the Modoc Interagency Communication Center and the Klamath Falls Interagency Fire Center. These forces, in addition to suppressing unwanted fires on refuge properties, assist other local, state, and federal agencies with their suppression needs, and in turn, they support fire suppression efforts in the Refuge Complex.

The Refuge Complex has averaged seven fires per year from 2001 through 2010. Because of the great geographic spread, two wildland fire engines are staffed during “fire season,” generally late May through late September. One engine crew is stationed at Tule Lake Refuge, headquarters for the Refuge Complex, in Tulelake, California. The second engine is stationed at the headquarters of the Klamath Marsh Refuge, north of Chiloquin, Oregon. Both wildland fire engines are ICS Type 3, carrying between 600 and 650 gallons of water and are staffed with three to five firefighters.

Fire is an integral component of refuge ecosystems in the Refuge Complex. It is used as a tool to accomplish resource management objectives. These objectives include, but are not limited to:

providing protection to structures located within wildland-urban interface zones within and adjacent to the refuges; enhancing and maintaining wildlife habitat; enhancing public use opportunities; reducing hazardous fuels; managing exotic and noxious plant species; promoting biological diversity and desired seral stages; preserving endangered species and critical habitat; and accomplishing basic maintenance needs such as disposal of vegetative waste and debris. In all uses of prescribed fire, there are consistent management requirements. These include measurable objectives, qualified personnel, quantified ranges of conditions under which burns will be conducted, a description of actions that will be taken if these conditions are exceeded, a monitoring and documentation process, and a review and approval process.

Although there are some risks to the use of prescribed fire, those risks are minimized by the implementation of these requirements. The failure to use prudently prescribed fire may carry greater risks and long-term ecological consequences than a fire program that does not use prescribed fire. Details of the fire management program on each refuge are provided in Sections 5.2 through 5.6.

Fish and Wildlife Management

Migratory Birds

The Service is responsible for the conservation and management of more than 800 species of migratory birds that occur in the country. In 2004, the Service released the 10-year strategic plan for the Migratory Bird Program, *A Blueprint for the Future of Migratory Birds* (Service 2004b). It calls for cooperation from all governments and partners to ensure the continued survival of migratory birds. The Blueprint identifies three priorities for the Migratory Bird Program: 1) address the loss and degradation of migratory bird habitat, 2) improve scientific information on bird populations, and 3) increase partnerships to achieve bird conservation. Implementation of this Refuge Complex CCP will complement these priorities by addressing needs of some Birds of Management Concern listed in the Blueprint.

Since 1983, the Service has conducted annual aerial waterfowl censuses to document waterfowl population trends during the fall and spring waterfowl migration. A secondary objective of the census is to document bald eagle population trends. This latter objective is easily accomplished in conjunction with the waterfowl census as bald eagles are often found in close proximity to waterfowl. The census is conducted twice per month starting in October and ending in April.

Integrated Pest Management

The Service pest management goal (569 FW 1) is to eliminate the unnecessary use of pesticides through the use of integrated pest management (IPM). IPM uses a combination of biological, physical, cultural, and chemical control methods (569 FW 1). This approach notes environmental hazards, efficacy, costs, and vulnerability of the pest.

When plants or animals are considered a pest, they are subject to control on refuges if the pest organism represents a threat to human health, well-being, or private property; the acceptable level of damage by the pest has been exceeded; state or local governments have designated the pest as noxious; the pest organism is detrimental to primary refuge objectives; and the planned control program will not conflict with the attainment of refuge objectives or the purposes for which the refuge is managed (7 RM 14.2 of the Refuge Manual and 569 FW 1).

On the covered refuges, weed management activities include mapping of weed infestations with GPS-linked data loggers and suppression of weed infestations using chemical, biological, and mechanical control methods. Lower Klamath and Tule Lake Refuges have an IPM Plan that was prepared for lease land farming in 1998.

Wildlife Diseases

Since the 1940s when 100,000 birds died of botulism, waterfowl disease problems have occurred almost annually on Tule Lake and Lower Klamath Refuges; avian cholera and botulism type C cause the greatest mortality. Avian cholera was first recorded in 1955 and some winters have claimed up to 20,000 birds. Other chronic disease problems that occur each year but are not contagious and cause less mortality include lead poisoning, aspergillosis, and tuberculosis.

The following summarizes diseases that have occurred in the Refuge Complex or are of concern in the region.

Avian Botulism. Avian botulism is a paralytic disease caused by ingestion of a toxin produced by the bacteria *Clostridium botulinum*. This bacteria is widespread in soil and requires warm temperatures, a protein source, and an anaerobic (no oxygen) environment in order to become active and produce toxin. Decomposing vegetation and invertebrates combined with warm temperatures can provide ideal conditions for the botulism bacteria to activate and produce toxin. Several types of toxin are produced by strains of these bacteria, with birds being most commonly affected by type C and to a lesser extent type E.

Birds either ingest the toxin directly or may eat invertebrates (e.g., chironomids, fly larvae) containing the toxin. Invertebrates are not affected by the toxin and store it in their body. A cycle develops in a botulism outbreak when fly larvae (maggots) feed on animal carcasses and ingest toxin. Ducks that consume toxin-laden maggots can develop botulism after eating as few as three or four maggots.

Healthy birds, affected birds, and dead birds in various stages of decay are commonly found in the same area. The toxin affects the nervous system by preventing impulse transmission to muscles, which results in flaccid paralysis. Consequently, birds are unable to use their wings and legs normally or control the third eyelid, neck muscles, and other muscles. Birds with paralyzed neck muscles cannot hold their heads up and often drown. Death can also result from water deprivation, electrolyte imbalance, respiratory failure, or predation.

Botulism losses have been documented on Upper Klamath, Lower Klamath, and Tule Lake Refuges. Outbreaks usually occur during the hot summer months of July and August, with the earliest documented mortality found on June 16. Losses of over 50,000 waterfowl were recorded in the early 1950s. Since that time, unit sizes have been reduced and water management capabilities improved. Botulism losses are not as severe today as they were 30 years ago, but losses still occur annually and the potential for severe die-offs is always present.

Avian Cholera. Avian cholera is the most important infectious disease among North American waterfowl and epizootics often kill thousands of birds (U.S. Geological Survey 2002). The disease is caused by the bacterium *Pasteurella multocida*. Transmission to susceptible birds from contaminated wetlands or from direct bird-to-bird contact are the most likely routes of transmission during epizootics (Samuel, Botzler, and Wobeser 2007). Transmission by inhalation probably occurs through production of aerosols (formed when high densities of birds land, take

flight, bathe, or disturb the water surface and eject high bacterial concentrations into the atmosphere) (Samuel et al. 2007). Transmission may also occur via ingestion of bacteria in contaminated food or water (Samuel et al. 2007). Carcasses that remain in wetlands can be an important source of the bacterium in water. This disease has occurred almost annually at the Lower Klamath, Tule Lake, or Upper Klamath Refuges. In recent years, losses at these refuges have approached more than 10,000 birds.

West Nile Virus. Most often, West Nile virus is spread by the bite of an infected mosquito. Mosquitoes become infected when they feed on infected birds. Infected mosquitoes can then spread West Nile virus to humans and other animals when they bite.

According to the Centers for Disease Control (CDC) (2009), approximately 80% of people (about 4 out of 5) who are infected with West Nile virus will not show any symptoms at all. Up to 20% of the people who become infected have symptoms such as fever, headache, and body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach, and back. Symptoms can last for as short as a few days, though even healthy people have become sick for several weeks. About one in 150 people infected with West Nile will develop severe illness.

The surveillance program for West Nile virus began in 2001 in Oregon, and West Nile virus was first diagnosed in Oregon in 2004 (DeBess 2009). Twenty-seven cases of West Nile virus in humans were reported in Oregon in 2007 and 17 in 2008. Of these cases, two were reported in Klamath County in 2007 and one in 2008 (DeBess 2008, 2009). No birds in Klamath County were tested for West Nile virus in 2007 or 2008 (DeBess 2008, 2009).

In California, 409 cases of West Nile virus in humans were reported in 2007 and 441 in 2008 (California Department of Public Health et al. 2009). However, no cases occurred in Modoc or Siskiyou counties (California Department of Public Health et al. 2009). One bird from Modoc County was reported as positive for West Nile virus in 2008 and one as likely West Nile virus in 2007 (California Department of Public Health et al. 2009). In Siskiyou County, no positive birds were reported in 2008 and four were reported positive in 2007 (California Department of Public Health et al. 2009).

Mosquito management on refuges is conducted according to established policy of the NWRS. Generally, refuges will not conduct mosquito monitoring or control, but these activities may be allowed under special use permits (SUPs) in cooperation with federal, state, or local public health authorities. When necessary to protect the health of a human, wildlife, or domestic animal population, management of mosquito populations on NWRS lands is allowed using effective means that pose the lowest risk to wildlife and habitats.

Avian Influenza. Bird flu, the popular name for avian influenza, is a disease primarily found in poultry and wild birds. The highly pathogenic H5N1 strain of avian influenza has on rare occasion infected humans, typically through extensive contact with infected poultry, with serious consequences when infection does occur. Avian influenza has not been detected in North America (Service 2009). However, the potential exists for wild migratory birds to carry the virus to North America or for the virus to be introduced through the legal wild bird pet trade, shipment of goods from overseas, smuggling, or other means. The Service and other agencies of the United States Government are taking steps toward early detection of the disease and minimization of its potential impact should it reach the United States.

5.2 Lower Klamath National Wildlife Refuge

Lower Klamath Refuge was established as the nation's first waterfowl refuge in 1908 by President Theodore Roosevelt because of its tremendous wildlife resources. Its size was reduced by subsequent executive orders and later increased by the 1964 Kuchel Act and new land acquisitions. The combined area of Lower Klamath Refuge, the Kuchel Act tracts, and the new acquisitions is 51,247 acres, with roughly 47% in wetlands, 38% in rangelands/pasture, and 15% in croplands.

The Lower Klamath Refuge is the largest in the complex and contains a varied mixture of intensively managed shallow marshes, open water, grassy uplands, and croplands.

5.2.1 Physical Environment

Geographic Setting

Lower Klamath Refuge is located about 5 miles southwest of Merrill in Klamath County, Oregon, and west of Tule Lake Refuge in Siskiyou County, California (see Figure 1.2). These two refuges are separated by Sheepy Ridge, a 2-mile-wide ridge several hundred feet high.

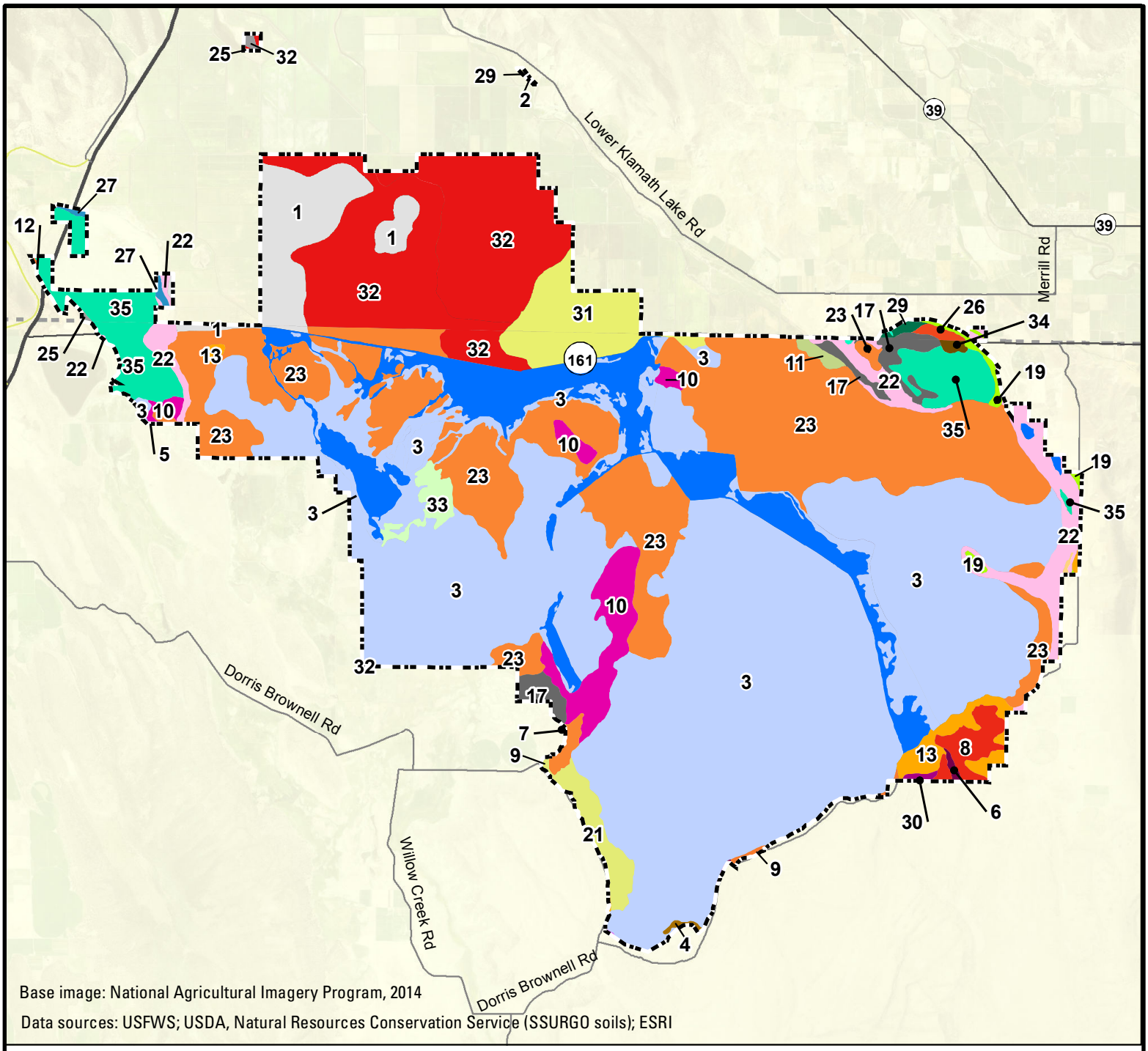
Geology

The Lower Klamath Lake basin was formed by block faulting and igneous activity and partially filled by sediment (i.e., cinders, ash, and pumice) carried by meltwater from the Cascade Range to the lake (Dicken 1980).

Soils

The soils of Lower Klamath Refuge developed under the former Lower Klamath Lake. They are a result of lacustrine deposits and volcanic ash. Lacustrine deposits consist of materials that have settled out of bodies of still water. Volcanic ash is material that has been reworked by wind, and in some places, by water NRCS 1985. A distinguishing feature of the soils is the high amount of diatomaceous material present (Reclamation 1987). Diatomaceous material is formed from the siliceous remains of primitive plants called diatoms. Figure 5.1 illustrates the soils within the approved acquisition boundary of the refuge. There are 32 soils series or soil complexes on the refuge. Of these, the seven soil series described below comprise 87% of the soil on the refuge, with the Capjac and Lamath soil series comprising the bulk of the soil. Almost 7% of the refuge is composed of water. The remaining 25 soil series make up a little over 6% of the refuge. The properties of the primary soil series that underlie the refuge are as follows.

Algoma silt loam: The Algoma series consist of deep, poorly drained soils that formed in stratified lacustrine deposits. These soils formed in recent lake sediments consisting of diatoms, ash, and similar materials. Algoma soils are on drained lake bottoms and floodplains and have slopes of 0% to 1%. Runoff in these soils is very slow. Algoma soils are used for irrigated barley, pasture, alfalfa, and wildlife habitat. Drained areas where soils have not been reclaimed for agriculture have a plant cover consisting mostly of alkali saltgrass. The Algoma series is 3.00% of the refuge, and consists of 9.58% organic matter.



Approved acquisition boundary

Water

soil type

- 1- Algoma silt loam
- 3- Capjac silt loam
- 4- Capona-Rock outcrop complex
- 5- Dehill fine sandy loam
- 6- Demox-Rubbleland complex
- 7- Demox stony sandy loam
- 8- Dunnlake-Rangee complex
- 9- Eastable loam
- 10- Forbar fine sand
- 11- Fordney loamy fine sand
- 12- Harriman loam
- 13- Hedox-Porterfield complex
- 14- Henley-Laki loams
- 16- Inlow-Ocho complex
- 17- Laki-Henley complex
- 19- Laki fine sandy loam
- 20- Laki loam
- 21- Lalos-Blownout land complex
- 22- Lalos very fine sandy loam
- 23- Lamath silt loam
- 24- Lorella-Fiddler very complex
- 25- Lorella very stony loam
- 26- Malin clay loam
- 27- Malin variant silt loam
- 28- Salisbury-Denbar complex
- 29- Scherrard clay loam
- 30- Searles-Truax-Orhood complex
- 31- Teeters silt loam
- 32- Tulana silt loam
- 33- Tulana variant mucky peat
- 34- Tulebasin mucky silty clay loam
- 35- Zuman silt loam

Figure 5.1. Soils - Lower Klamath Refuge

0 1 2 4 miles

Tulana silt loam and Tulana variant mucky peat: The Tulana series consists of very deep, poorly drained soils that have formed in lacustrine sediments high in diatoms. Tulana soils are on lake bottoms and have slopes of 0% to 1%. Under natural conditions the soils are ponded. These soils have moderately poor permeability. The Tulana series is 10.00% of the refuge, with Tulana silt loam consisting of approximately 6.11% organic matter, and Tulana mucky peat soils containing 28.91% organic matter.

Teeters silt loam: The Teeters series consists of deep, poorly drained soils that formed in silty diatomaceous sediments. Teeters soils are on floodplains or drained lake bottoms and have slopes of 0% to 1%. These soils are poorly drained with very slow runoff and slow permeability. These soils are used for irrigated pasture and barley, wildlife habitat, and recreation. Inland saltgrass and Baltic rush are the major plants on un-reclaimed soils. The Teeters series is 3.00% of the refuge, and consists of 1.19% organic matter.

Lamath silt loam: The Lamath series consists of deep, poorly drained soils formed in stratified lacustrine derived from diatoms, volcanic ash, and extrusive igneous rock. Lamath soils are in lake basins and have slopes of 0% to 1%. Lamath soils are poorly drained and runoff is slow. These soils are flooded for periods of 1 to 3 weeks in March, April, or May about once every 2 years. An apparent water table occurs at depths of 1.0 foot to 2.5 feet from March through September unless artificially drained. These soils are used for irrigated crops. Native vegetation on these soils is inland saltgrass and meadow barley. The Lamath soil series is 20.0% of the refuge, and consists of 7.5% organic matter.

Zuman silt loam: The Zuman series consists of deep, poorly drained, sodic soils that formed in lacustrine sediments weathered mainly from tuff, diatomite, and basalt. Zuman soils are on lakebeds or floodplains and have slopes of 0% to 1%. These soils are poorly drained with very slow runoff and moderately slow permeability. These soils are used for pasture and wildlife habitat. Vegetation on un-reclaimed soils is inland saltgrass. The Zuman series is 3.0% of the refuge, and consists of 0.5% organic matter.

Capjac silt loam: The Capjac series consists of very deep, poorly drained soils that formed in lacustrine deposits influenced by high amounts of volcanic ash and diatoms. Capjac soils occur on lake basins and have slopes of 0% to 1%. These soils are poorly drained with medium surface runoff and moderate permeability. These soils have a water table at depths of 1.5 to 3.0 feet from January to December. Capjac soils are used for irrigated cropland, wildlife habitat, and rangeland. Cattails and bulrush are the primary plants found on soils that have not been reclaimed for agriculture. The Capjac series is 45.0% of the refuge, and consists or 7.5% organic matter.

Lalos very fine sandy loam: The Lalos series consist of deep, well-drained soils on aeolian deposits eroded from lacustrine sediments. Lalos soils are on lakeshore dunes and have slopes of 2% to 15%. Soils in this series are well drained with slow to medium runoff, and slow permeability. Lalos soils are used for cropland and rangeland. Native vegetation on these soils is greasewood, hopsage, basin wildrye, and inland saltgrass. The Lalos series is 3% of the refuge, and consists of approximately 2% organic matter.

With the exception of the Lalos soil series, the slopes of 0% to 1% for other soil types found on the refuge means that there is a low potential for water-based erosion. Soils with slopes of more than 2% are subject to water-based erosion from either natural runoff or from irrigation if not carefully managed (NRCS 1985). With the exception of the Lalos soils series, the soils on Lower Klamath Refuge are poorly drained. According to the NRCS, on poorly drained soils water is removed so slowly

that the soil is wet at shallow depths periodically during the growing season or remains wet for long periods. On these types of soils most crops cannot be grown unless the areas are artificially drained. This soil characteristic facilitates the cropping of winter wheat where water is applied only once.

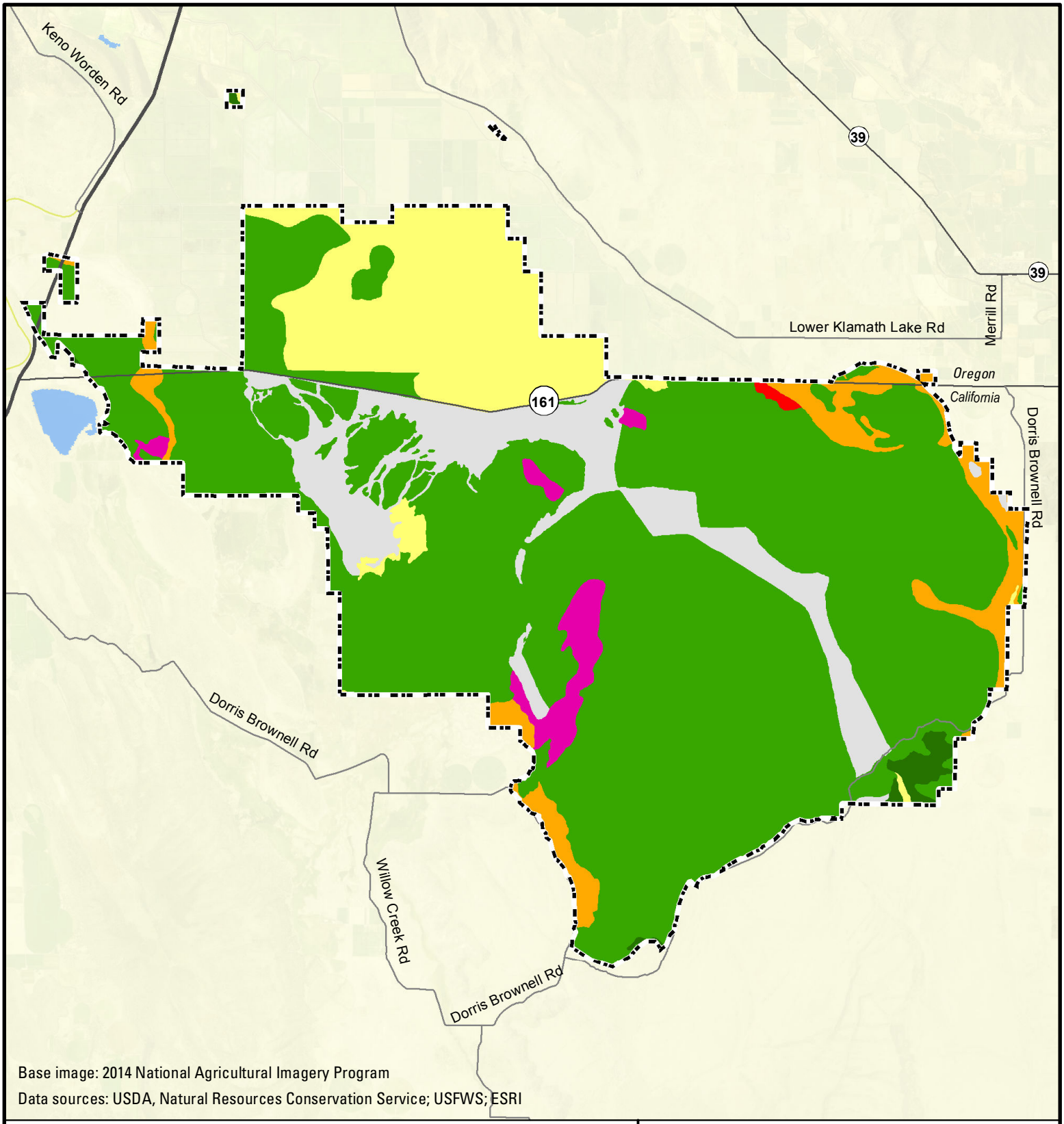
The NRCS has developed an index to rate the potential for soils to be eroded by wind. The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, and organic matter. Soil moisture and frozen soil layers also influence wind erosion. Figure 5.2 illustrates the soil erodibility from wind at Lower Klamath Refuge. On Lower Klamath Refuge most soils have a low to moderate level of wind-based erosion. On a scale of 0 to 6, the vast majority of the refuge is rated as a 2 or a 3, which includes the Lamath and Capjac series that comprise 65% of the refuge. A small percentage of the refuge has sandy, silty soils (such as the Lalos and Teeters series) that are highly wind erodible and are ranked between 4 and 6 on the NRCS index.

Hydrology

The hydrology of Lower Klamath Refuge has been altered greatly by the effects of drainage and irrigation (Weddell 2001). Historically, the refuge was a large, shallow lake and wetland area that was flooded naturally with overflow from the Klamath River during the spring (Mayer 2005). Today, the refuge is isolated from the river by a railroad bed that serves as a dike.

Lower Klamath Refuge receives most of its water from two sources: direct project diversions from the Klamath River through the Ady Canal, and project return flows from Tule Lake sumps via the D Plant. Reliable data for both water sources are available from 1981 to the present and are shown in Figure 5.3.[1] **Klamath Drainage District installed infrastructure to recirculate drain water. An estimated 7,953 acre-feet of drain water from the north side of the district is recycled back into Ady Canal at the Westside Pumping Plant during irrigation season.** Deliveries of direct project diversions through the Ady Canal to the refuge (red line on Figure 5.3) were fairly stable through the 1980s and 1990s. Low deliveries observed in the 1980s were because these years were exceptionally wet and water needs were met through precipitation rather than project deliveries. Historically the main water issue on Lower Klamath Refuge was limited drainage capacity and too much water rather than too little (Service1960–1973). In the six drought years in the first half of the record, 1981 through 1997, the refuge received an average of 28,000 acre-feet of direct project diversions from the Ady Canal. Even after the federal ESA listings of the 1980s and 1990s put limitations on the availability of project water supply, in drought years 1992 and 1994, Lower Klamath Refuge still received 21,000 acre-feet and 42,000 acre-feet, respectively, of direct project diversions. The main effect of the federal ESA listings on the refuge water supply during drought years was on the D Plant return flows, which decreased substantially in 1992 and 1994, as can be seen by the blue line in Figure 5.3.

[1] These deliveries are for the California portion of Lower Klamath Refuge and do not include any water delivered to the Area K lease lands in Oregon through the Klamath Drainage District contract. Data are from Klamath Falls Reclamation Office.



Base image: 2014 National Agricultural Imagery Program

Data sources: USDA, Natural Resources Conservation Service; USFWS; ESRI

Approved acquisition boundary

Soil Erodibility (scaled, low to high)	% of total area
0	10.3
1	0.9
2	68.9
3	12.9
4	4.8
5	0.2
6	2.0

Figure 5.2. Soil Erodibility from Wind - Lower Klamath Refuge

0 1 2 4 miles

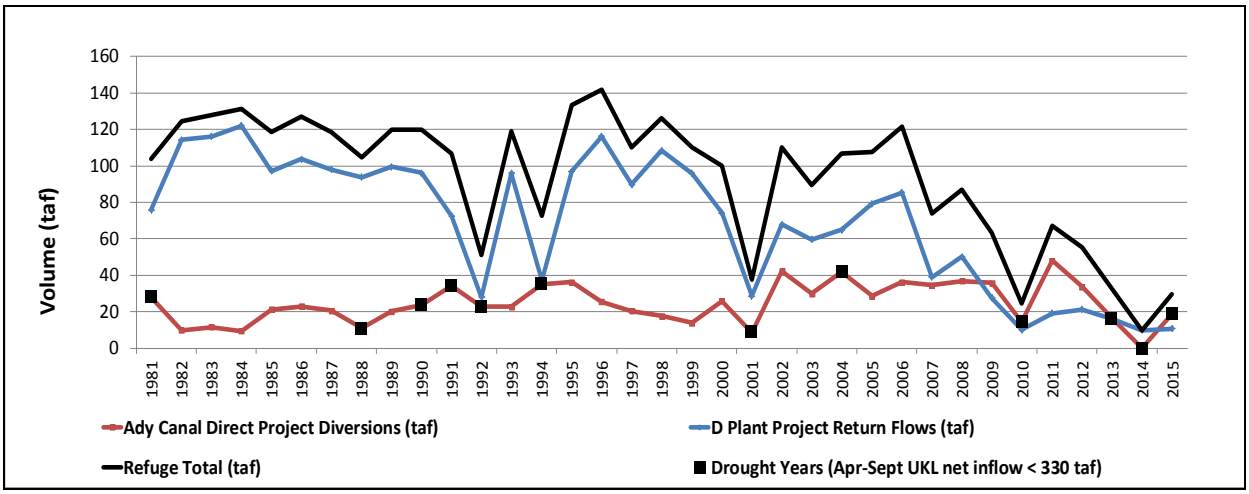


Figure 5.3. Lower Klamath Refuge annual water supply (Jan-Dec) by source (Ady Canal and D Plant) for the period 1981-2015. Drought years are defined by Apr-Sept Upper Klamath Lake net inflows less than 330,000 acre-feet.

More recent drought years associated with limited project water availability have seen substantial reductions in Ady Canal deliveries to Lower Klamath Refuge (red line on Figure 5.3), mainly due to unresolved questions about within-project priority. Compounding the water supply problems at the refuge is the fact that D Plant pumping of project return flows from Tule Lake Refuge to Lower Klamath Refuge also has declined significantly in recent years, following the expiration of a 50-year-old contract in 2006 that supplied low-cost power to the project irrigators (DOI and California Oregon Power Company 1956). In contrast to the 1980s and 1990s, in the six drought years in the last half of the record (1998–2015), the refuge has been nearly dry, only receiving an average of 13,000 acre-feet from the Ady Canal, as contrasted with refuge water needs and historical deliveries of over 100,000 acre-feet annually. In 2014, there were zero Ady Canal deliveries to Lower Klamath Refuge and in 2015, 19,000 acre-feet (through November 2015). In comparison, the irrigated lands on Tule Lake Refuge have received full deliveries in recent years (data not shown). The urgency of water issues at the refuge has been raised since the refuge is now essentially dry, a condition not observed since the 1930s.

Part of the reason for the decline in Ady Canal deliveries to Lower Klamath Refuge is the inconsistency over time on within-project priority for the refuge. Reclamation's first Project Drought Plan (Reclamation 1992) explicitly classified all agricultural lease lands within the California and Oregon portions of Lower Klamath Refuge (Area F or White Lake, Area K refuge lease lands, other federal lease lands) as an A priority, along with the Tule Lake lease lands. Although the 1992 Drought Plan did not address the within-project priority of non-lease, irrigated lands on Lower Klamath Refuge, these lands received adequate project deliveries through the Ady Canal in 1992 and 1994, as noted above. Reclamation's annual crop reports from 1994 to 2010 consistently listed all irrigated lands in Lower Klamath Refuge as an A contract with an A priority.

The extremely dry year in 2010 heralded a change in deliveries for Lower Klamath Refuge, with Reclamation's 2010 Operations Plan (Reclamation 2010) stating that there would be little or no water supply for the refuge (for the first time). Thereafter, Reclamation's Drought Plans in 2012 through 2014 explicitly changed the Lower Klamath Refuge Area K lease land priority from an A

to a B priority, on the basis that that area currently receives water through the Klamath Drainage District Warren Act contract. The drought plans continued to be silent on the within-project priority for the non-lease, irrigated lands on the refuge. The local Reclamation office has stated that they are not able to make a determination of within-project priority for Lower Klamath Refuge, since these lands are not covered by water supply contracts (Reclamation 2013b). As a result of these developments, the refuge has received very little water in the last 3 years.

As described above, starting in 2006, pumping costs for Klamath Project irrigators increased dramatically due to the expiration of PacifiCorp's Federal Energy Regulatory Commission license and the expiration of a reduced rate power contract. Prior to rate increases, the average water pumping cost was $2.25 per acre. The average water pumping cost in 2014 was $45 per acre (Reclamation 2014). This sharp increase in costs led to increased irrigation efficiency of the Tulelake Irrigation District, less water flowing into Tule Lake, and dramatically decreased discharge entering Lower Klamath Refuge through the D Plant (from Tule Lake).

Data provided by Reclamation including discharge entering the Lower Klamath Refuge through the D Plant (from Tule Lake), outflow from the refuge at Klamath Straits Drain (KSD) at Stateline (or "Headworks"), KSD at E-EE Pumps (downstream of Area K lease lands), and KSD at F-FF Pumps (at Highway 97, near the Klamath River) were assessed from October 1999 through October 2016 (Reclamation Klamath Basin Area Office, October 20, 2016, pers. comm.). Starting in 2007, there was a clear decrease in operation of the D Plant and associated flows pumped from Tule Lake to the Lower Klamath Refuge (Figure 5.3a).

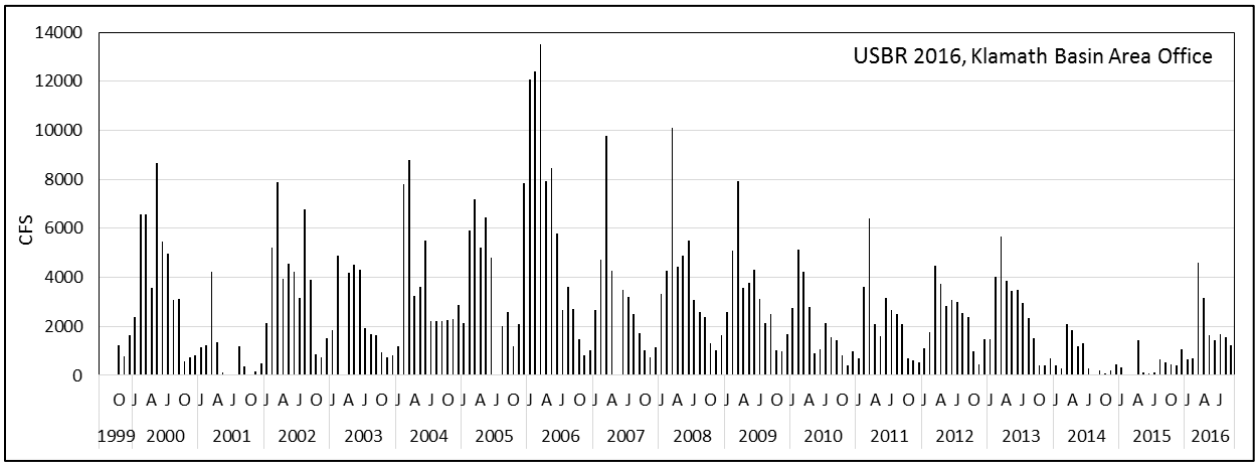


Figure 5.3a. Discharge from D Plant by month, October 1999 through September 2016.

Most of the water that was pumped to or drained onto the refuges was retained within the refuges and little water was discharged through Klamath Straits Drain at Stateline to the Klamath River (Figure 5.3b). Average flow for Klamath Straits Drain at Stateline from 2007 through 2016 was approximately 22% of the average flow at the same location from 1999 through 2006.

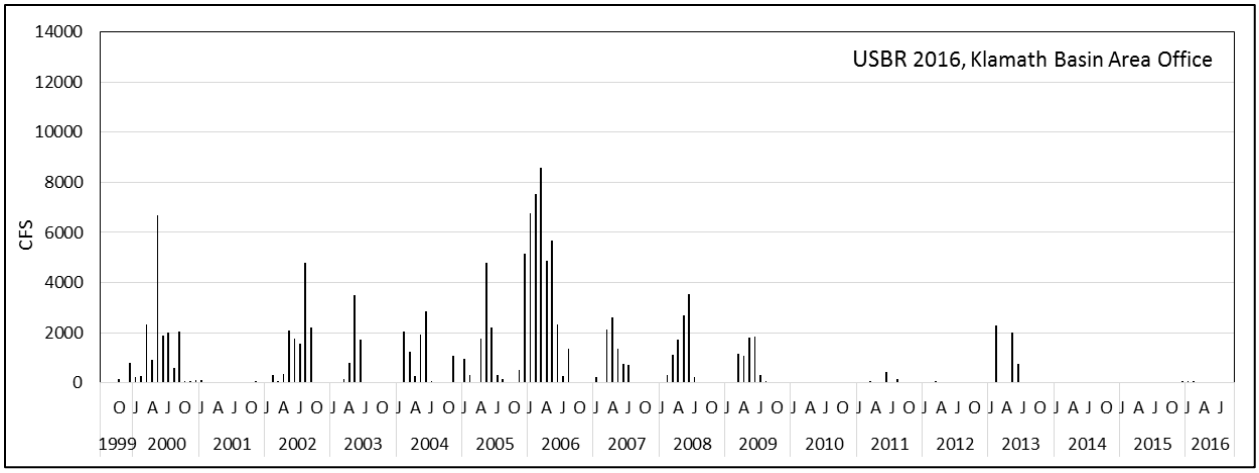


Figure 5.3b. Discharge at Klamath Straits Drain at Stateline by month, October 1999 through September 2016.

Discharge to the Klamath River is represented by flows in KSD at the F-FF Pumps (Figure 5.3c). From 2007 through 2016, average flow exiting Lower Klamath Refuge at Stateline was only approximately 12% of average flow entering the Klamath River through KSD at F-FF Pumps (compared to 34% of average flow from 1999 to 2006).

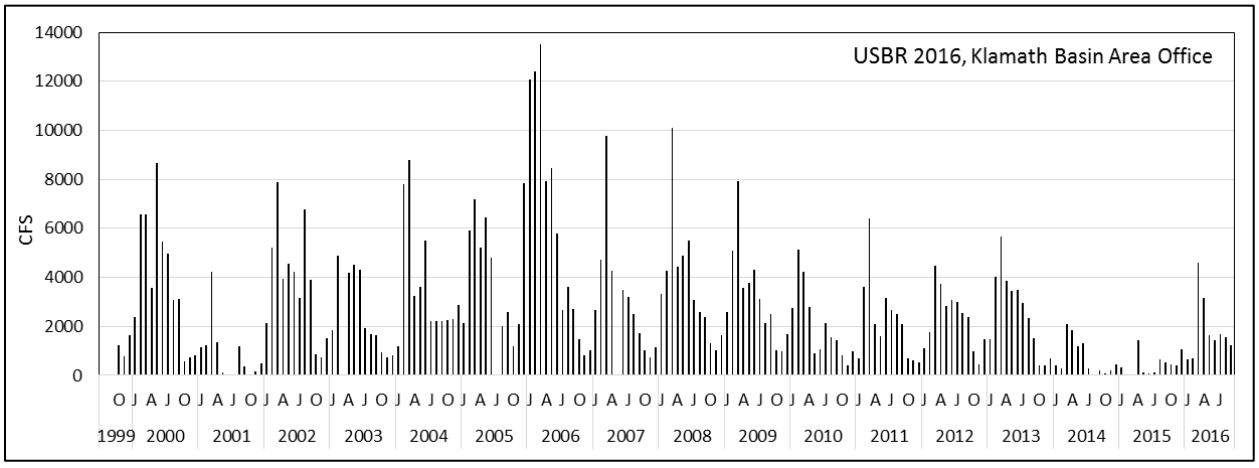


Figure 5.3c. Discharge from Klamath Straits Drain at F-FF Pumps by month, October 1999 through September 2016.

Discharge exiting Area K lease lands at the E-EE Pumps is displayed in Figure 5.3d. These waters, in addition to drainage waters from the Klamath Drainage District, contribute return flows to KSD. From 1999 through 2006 approximately 82% of the average flow at the F-FF Pumps could be contributed to water exiting the Area K lease lands at the E-EE Pumps, while from 2007 through 2016 only 44% could be contributed to this water. The average flow at the E-EE Pumps from 2007 through 2016 was approximately 35% of the average flow at the E-EE Pumps from 1999 through 2006.

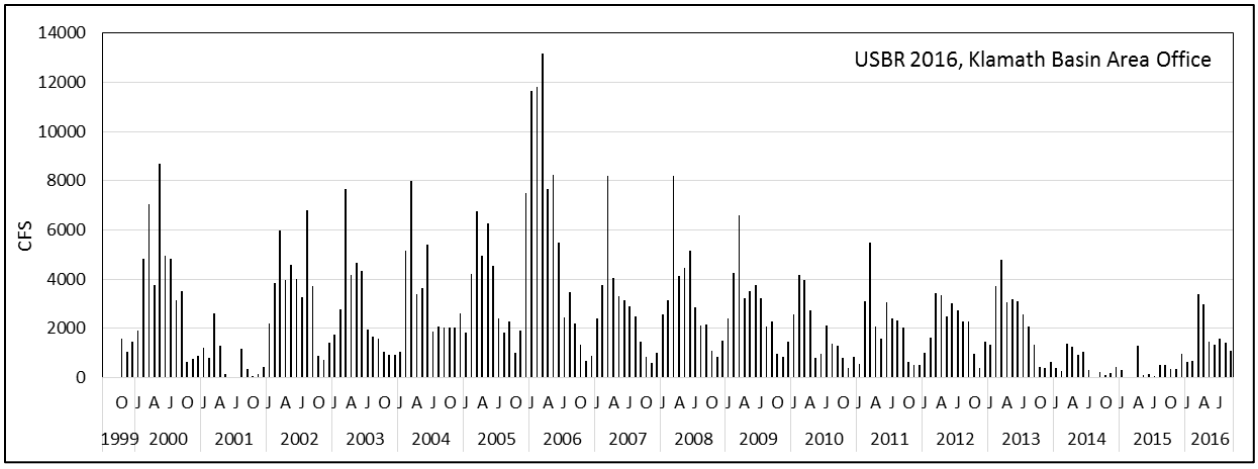


Figure 5.3d. Discharge from Klamath Straits Drain at E-EE Pumps by month, October 1999 through September 2016.

In summary, historic deliveries of direct project diversions to Lower Klamath Refuge have drastically declined in recent years, mainly due to the unresolved question of within-project priority for Lower Klamath Refuge. Declines in D Plant pumping as well as very low deliveries from the Ady Canal to Lower Klamath Refuge have heightened the sense of urgency with respect to water supply on the refuge. In contrast, irrigated lands at Tule Lake Refuge have an A priority and have received full deliveries in most years.

Water Quality

During winter and early spring, water quality conditions are generally good in the Lower Klamath and Tule Lake Refuges (Service 1998a). However, during periods of protracted ice cover, low or lethal dissolved oxygen conditions sometimes occur (Service 1998a). Water quality is generally better in the winter because temperatures are cooler. Water quality problems are primarily related to excessive natural or human-caused nutrients in the water. High levels of sunlight and elevated water temperatures in summer lead to high rates of photosynthetic activity which results in wide fluctuations in dissolved oxygen as well as pH. Extreme pH and **dissolved oxygen** levels can be harmful to aquatic life. In contrast, water quality during the remainder of the year is generally poor, with frequent exceedances of federal and state water quality criteria for the protection of freshwater aquatic life. Criteria that are frequently exceeded include water temperature, pH, dissolved oxygen, and un-ionized ammonia (Oregon Department of Environmental Quality data presented during meetings of the Total Daily Maximum Loading Committee, 1996-1998 for the Upper Klamath River and Lost River subbasins) (Service 1998a). The poor water quality at both Tule Lake and Lower Klamath Refuges originates from the source waters of Lost River and Upper Klamath Lake and its tributaries, which are naturally enriched in nitrogen and phosphorus. **Rykbost and Charlton (2001) describe nutrient concentrations in Upper Klamath Lake at various times of the year (which increase through the summer) and describe nutrient concentrations and loads from Upper Klamath Lake that are due to both natural sources (spring and river inflows) and anthropogenic sources (conversion of wetlands and marshlands to agricultures, drainage of agricultural lands into Upper Klamath Lake, and increased internal loading) (Rykbost and Charlton 2001).** These source waters have been further degraded by nutrients and other chemicals from nonpoint sources surrounding these waters, including flood irrigation and cattle use of pasture lands, and urban, logging, and agricultural land disturbances. Canal and drain maintenance activities are additional

sources of sediments and nutrients, as are point sources, including sewage treatment plants and dairies upstream of the refuges (Kaffka et al. 1995; MacCoy 1994; Sorenson and Schwarzbach 1991; Winchester et al. 1995).

Oregon and California TMDL assessments have been completed for both the Lost and Klamath Rivers, and Upper Klamath Lake. Specific impariments and load allocations have been identified for the Tule Lake and Lower Klamath Refuges. The California and Oregon Lost River TMDLs address dissolved oxygen, ammonia, pH, and chlorophyll-*a*. Specific criteria were developed for dissolved oxygen and dissolved inorganic nitrogen (DIN) that would also address pH and chlorophyll-*a*. TMDL load allocations for dissolved oxygen were represented by carbonaceous oxygen demand (CBOD) and DIN. Allocations were defined as a 50% reduction in CBOD and DIN for overall non-point load allocations, including all irrigation drainage loads throughout the study area, which include lands within the Lower Klamath Refuge. Temperature was not identified in the California TMDL, and in Oregon temperature TMDLs are undergoing review.

Mayer (2005) completed a review of general nutrient-related water quality conditions on the Lower Klamath Refuge and found both short-term (season) and longer-term (April-November) changes in water quality by examining upstream and downstream conditions. For the longer-term periods total phosphorus and total nitrogen loads were reduced through the refuge system. During the spring season (April–June) total phosphorus and total nitrogen loads increased through the refuge, but in all other seasons the loads were reduced. For DIN, loads were reduced in all periods, and for dissolved inorganic phosphorus, loads were reduced over the entire period but increased in spring. The increase in loads exported from the system was presumed to be due to spring time operations including drainage from seasonal wetlands and farmed units.

Season long reductions (refuge inflow minus outflow) for total nitrogen and total phosphorus are both in excess of 50% (Mayer 2005). DIN, identified as a load allocation in the TMDL, is likewise reduced by over 50% through the refuge. Mayer (2005) also assessed three specific types of wetlands that exist on the refuge: seasonal, farmed, and permanent wetlands. For all wetland types, inorganic nitrogen and inorganic phosphorus, and particulate nitrogen and particulate phosphorus loads were retained in all types of wetlands with overall mass reductions ranging from approximately 15% to over 80% due to processing, sedimentation, and uptake. One exception was inorganic phosphorus in the seasonal wetland during the summer period, which was a net source (Mayer 2005). **Similarly, Danosky and Kaffka (2002) found that wetlands and farming practices in the southern portion of the Klamath Project result in the net removal of nutrients from the waters diverted for irrigation on a yearly basis.** Operations of these managed units can have water quality impacts on the response of each wetland due to residence time, vegetation management, land use activities, wetting and drying cycles, and other factors. These results are typical for a range of wetlands that typically reduce nutrients through uptake, processing, and settling (Crites and Tchobanoglous 2005; Kadlec and Knight 2004).

Although nutrient loads have been found to generally decrease over refuges and farmed units on an annual basis, nutrient concentrations generally increase from inputs to discharge waters. Mayer (2005) found nitrogen and phosphorus concentrations to generally increase from wetland inflows to wetland discharge. Danosky and Kaffka (2002) found total phosphorus and total nitrogen concentrations to increase at each subsequent step over the pathway: input waters to Tulelake Irrigation District (TID) at the J canal, water leaving the Tule Lake sumps at the D Plant, water leaving Lower Klamath Refuge at KSD at Stateline, and water at the end of KSD prior to discharge into the Klamath River.

Dissolved oxygen processes have not been explicitly assessed on the refuge, and CBOD data are unavailable to determine oxygen demands at this time. Long-term water quality monitoring completed by Reclamation does provide insight into dissolved oxygen throught the refuge. While limited data are available for the Ady Canal, there are long-term records (1991–2013 Reclamation Water Quality Data) at the D Plant (representing inflow to the refuge) and KSD at Stateline (representing ouflow from the refuge). Review of these long-term data indicates that average upstream and downstream dissolved oxygen concentrations are 8.2 milligrams per liter (mg/L). Short-term variations (e.g., daily, weekly) are indicated by maximum and minimum dissolved oxygen concentrations that are on the order of 20 mg/L and 1 mg/L, repectively, at both locations. Dissolved oxygen below 5 mg/L is below the state minimum of 5 mg/L, so significant impacts are present under current conditions.

Discharge entering the Lower Klamath Refuge through the D Plant (from Tule Lake), outflow from the refuge at KSD at Stateline (or "Headworks"), KSD at E-EE Pumps (downstream of Area K lease lands), and KSD at F-FF Pumps (at Highway 97, near the Klamath River) were assessed from October 1999 through October 2016 within the Hydrology section above (USBR Klamath Basin Area Office, October 20, 2016, pers, comm.). Starting in 2007, there was a clear decrease in operation of the D Plant and associated flows pumped from Tule Lake to the Lower Klamath Refuge (see Figure 5.3a).

Although water draining the Area K lease lands presumably constitutes a significant portion of the KSD water (see Section 5.2.1, Hydrology), this water is largely conveyed to the lease lands via the Ady Canal, and not from Lower Klamath Refuge. Refuge drainage volumes are low compared to other water sources to the KSD, particularly in recent years (Reclamation data, personal communications with Klamath Basin Area Office). Therefore, nutrient loads and associated water quality impacts of refuge drainage waters on the Klamath River have been minimized in recent years. Additionally, spring (April through June) includes some of the highest flows in the Klamath River (Figure 5.3e.). Therefore, seasonally elevated discharges with potentially elevated nutrient concentrations associated with draining and discharging lease lands are typically coincident with seasonally elevated Klamath River flows.

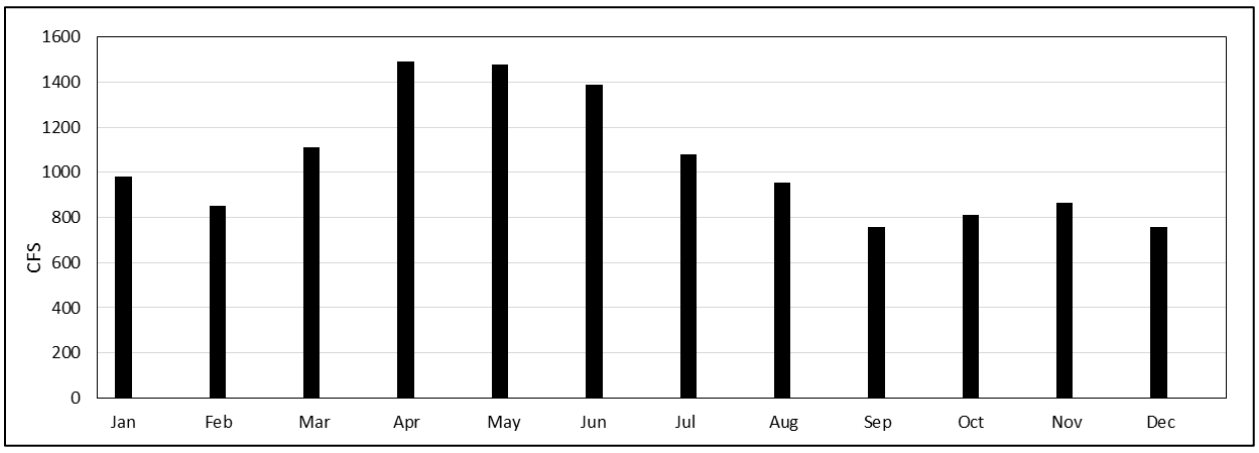


Figure 5.3e. Mean monthly discharge at Link River at Klamath Falls, Oregon (USGS station 11507500), October 1999 through June 2016.

Because the TMDL implmentaton planning process is ongoing, the impact of the refuges on reduction in nutrients and on dissolved oxygen concentrations on final TMDL implementation actions has not been defined at this time. The TMDL includes specific information on process and planning, as well as possible BMPs to be considered in a collaborative stakeholder process.

Fire History

As of 2015, 61 wildfires had been recorded on Lower Klamath Refuge. However, formal recordings of wildfires were virtually non-existent until the mid-1940s, and even then they were sporadic at best. Many non-specific references are reported for peat fires burning in and around present-day Unit 4 for many years during the late 1940s through the mid-1950s. These reports seem quite reasonable as the unit is known for its highly organic and combustible soils and peat fires still occur in the same area (most recently the Oklahoma fire in 2003).

The first 20 years of fire records and reports do not provide information to determine their specific cause. However, more recently the refuge has experienced a growing number of human-caused incidents. Campfires had prevalence for some time until regulations prohibited camping and, expectantly, that cause category diminished to zero. At the same time, a number of escaped prescribed fires, both originating on and off the refuge, have resulted in wildfires.

In August 1998, a fire caused by equipment use started on the south end of the Lower Klamath Refuge. The refuge fire burned 1,500 acres of refuge land as well as 9,700 acres of private, U.S. Bureau of Land Management (BLM), and U.S. Forest Service land. This fire required the mobilization of an incident management team. An extensive area of organic soils ignited, requiring a lengthy control effort. Several tort claims were filed against the Service by private landowners.

5.2.2 Biological Resources

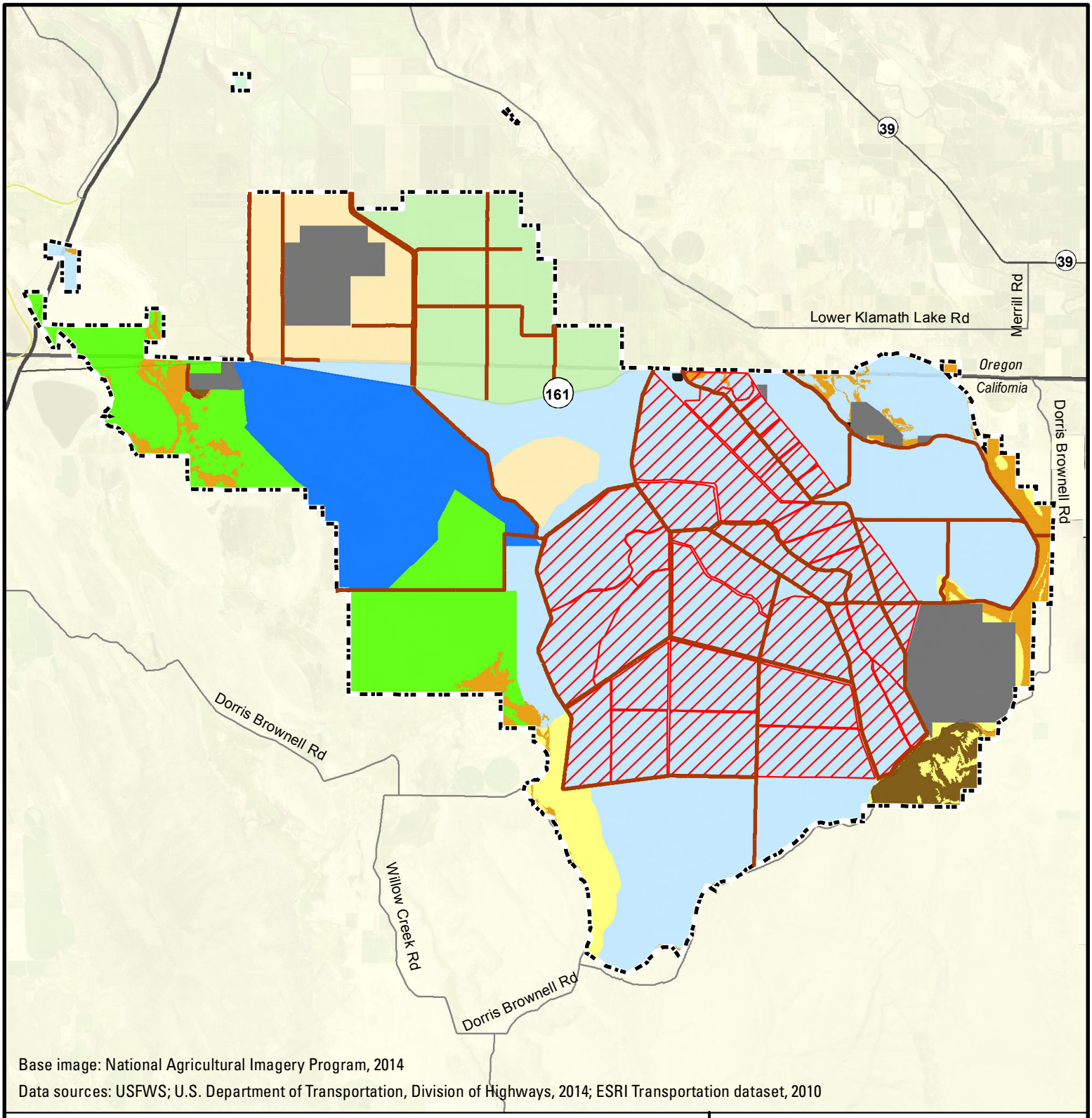
The Lower Klamath Refuge is a varied mixture of shallow freshwater marshes, open water, uplands, and croplands that are intensively managed to provide habitat for waterfowl and other wetland-dependent wildlife. The predominant habitat component provided is the seasonally flooded wetland. Other important habitats provided are permanently flooded wetlands, wet meadow, agricultural cropland units, and unflooded uplands.

Vegetation and Habitat Resources

Seasonally Flooded Wetlands

Depending on water availability, seasonally flooded wetlands cover up to one-third of the Lower Klamath Refuge land area or up to 16,000 acres (Figure 5.4). This habitat occupies the shallow peripheral areas of the original Lower Klamath Lake system. Seasonally flooded wetlands are characterized by a flooding regime extending less than year-round, but greater than 6 months (of which 2 months must be during the growing season).

This habitat type was likely a large proportion of the original Lower Klamath Lake and is critical to meeting the migratory waterfowl needs within the refuge as well as the Pacific Flyway (Fleskes and Battaglia 2004). In addition, this habitat provides brood areas for early nesting waterfowl species such as mallards (Mauser 1994a) and pintails and is extensively used by spring migrant shorebirds and other wildlife species.



Base image: National Agricultural Imagery Program, 2014

Data sources: USFWS; U.S. Department of Transportation, Division of Highways, 2014; ESRI Transportation dataset, 2010

- Approved acquisition boundary
- Refuge road
- Private inholding
- Developed
- Cooperatively farmed (rotated with grain production periodically)
- Agriculture (grain fields)
- Pasture/hay
- Wet meadow
- Managed wetland (permanent)
- Managed wetland (seasonal)
- Upland grassland
- Shrub/scrub habitat - greasewood dominant
- Shrub/scrub habitat - sagebrush dominant

Figure 5.4. Vegetation - Lower Klamath Refuge

0 0.75 1.5 3 miles

Management of seasonally flooded wetlands requires flooding during the early fall (September through November) and dewatering in late spring to early summer by gradually lowering the water level either by draining or by evaporation or a combination of both. This water management develops a productive wetland habitat that can be optimally used by migratory waterfowl and other wildlife.

The protracted removal of water during the growing season yields a complex mosaic of vegetative communities. Plant diversity is enhanced by uneven bottom contours which are exposed by a declining plane of water. As these "patches" of the bottom are exposed, they warm allowing germination of various plant species. Since these patches dry at different times, a specific plant association develops on each and results in a "patchwork" of differing plant associations in the unit.

The red goosefoot (*Chenopodium botryodes*) community in particular produces large numbers of seeds which are used by fall migrating mallards, pintails (Pederson and Pederson 1983), and other dabbling ducks. The invertebrate populations that develop on the foliage after flooding are sought by many species of migrating waterfowl (Pederson and Pederson 1983), shorebirds (Helmers 1992), and other marsh birds during spring migration and the subsequent breeding season. Aquatic invertebrates in particular are used by young waterfowl (Sugden 1973) and other breeding wetland wildlife species.

Smartweed (*Polygonum* sp.) is another important plant produced by seasonal flooding. This plant is found in association with other plant species or in extensive monotypic stands. During the fall, it is readily used by migrating waterfowl for food and cover. Like other seasonally flooded wetland plants, smartweed provides good substrate for aquatic invertebrates.

Over time, considerable areas of alkali bulrush develop in the seasonally flooded wetlands. Alkali bulrush is a prolific producer of seeds but they are not taken in significant amounts by waterfowl or other wildlife. However, the vegetative parts of the plant provide excellent cover for migrating and breeding waterfowl, and species such as redwing and yellow-headed blackbirds, sora and Virginia rails, and sandhill cranes make considerable use of alkali bulrush for nesting and brood rearing.

Both the seeds and the invertebrates provided by seasonally flooded wetlands are critical food items for migrating and breeding waterfowl, shorebirds, and other marsh birds.

Permanently Flooded Wetlands

Depending on water availability, up to 10,000 acres of permanently flooded wetlands are maintained on Lower Klamath Refuge. This habitat emulates the permanent emergent wetlands that typified the central deeper areas of historic Lower Klamath Lake. These wetland units are characterized by year-round flooding and contain three distinct plant communities adapted to permanent flooding. The emergent plant community is composed of those species rooted in the bottom substrate, but with stems and leaves extending above the water surface into the air. The submergent community has plants rooted in the bottom, but has no part of the plant extending above the water column. The third community is composed of the floating plants whose roots extend only into the water column and not into the bottom substrate.

Emergent vegetation is composed of hardstem bulrush, cattail, and occasional minor inclusions of river bulrush. Emergent stands range from pure cattail to pure hardstem bulrush or more likely a mixture of both.

The submergent plant community is dominated by sago pondweed with lesser amounts of baby pondweed (*P. pusillus*) and coontail (*Ceratophyllum demersum*). This community is found in open water zones where water depths range from 6 inches to 3 feet. Sago pondweed is a major food source to migrating canvasbacks which feed almost exclusively on sago tubers during their 3-month stay in the fall. Other species of waterfowl such as the redhead, American wigeon, lesser scaup, mallard, American coot (*Fulica americana*), and tundra swan consume the vegetative parts and seeds of this as well as other submergent plants.

Colonial nesting species such as white pelicans, double-crested cormorants, and great blue herons (*Ardea herodias*) use permanent wetland units for nesting. These units provide secure and remote sites required for nesting, and provide an abundant supply of fish, the primary food item for these birds. The western pond turtle (*Clemmys marmorata*) is frequently sighted in Unit 2, a permanently flooded wetland.

An additional use of permanently flooded wetlands is by molting waterfowl (July–September). Because these birds are flightless during this period, food, water, and cover must be in close proximity. Large, permanently flooded marshes on Lower Klamath Refuge are heavily used for this purpose. Ducks have been documented to travel over 300 miles from their nesting areas to these marshes to molt (Yarris et al. 1994).

Croplands

Lower Klamath Refuge croplands include fields of grass hay and small grains, primarily barley. The standing and waste grain left in farmed fields provides a highly sought, high-energy food source for some waterfowl species, pheasants, and sandhill cranes during the fall and early winter months. During the early winter when these fields are flooded for pre-irrigation, they are used not only by waterfowl, but also by bald eagles and other raptors, herons, egrets, gulls, and coyotes that are attracted to the large concentration of meadow voles displaced by the water. After these units are fully covered with water, they often show heavy use by waterfowl, especially tundra swans, in the early spring.

Wet Meadow

Depending on water availability, there are up to 5,700 acres of wet meadow on Lower Klamath Refuge. This vegetation type differs from the seasonally flooded marshes in that wet meadows are flooded for less than 6 months annually and less than 1 month during the growing season. The resultant vegetation is dominated by upland grasses and forbs and very little bulrush or cattail develops.

Five vegetative communities are predominant in this habitat type. They are the swamp senecio-baltic rush, low grass-forb, whitetop-foxtail barley, bluegrass-hairgrass, and saltgrass-spikerush types.

The senecio-baltic rush community covers perhaps 20% of the wet meadow. It is a tall forb community with swamp senecio and cinquefoil dominating the overstory and Baltic rush, whitetop, and tarweed providing the lower ground cover.

The low grass-forb community also covers about 20% of this habitat type and is characterized by short height and low vertical density. The substrate of this type is often highly pitted with shallow depressions that hold water longer into the spring than other areas and the soil is extremely soft when wet. Vegetation growth occurs later in the spring in these areas.

Plants common to this community include foxtail barley, rabbitfoot grass, *Muhlenbergia* sp., whitetop, Nevada bluegrass, and paintbrush.

When flooded, this is one of the most used types by spring migrant geese, ducks, and swans. Later during the season, it is a preferred nesting site for some shorebird species, such as the long-billed curlew and willet.

An additional 20% of the wet meadow type is covered by the whitetop-foxtail barley community. This vegetative type develops on slightly elevated areas that dewater a little earlier in the spring. It is low in height, but quite dense at ground level.

The bluegrass-hairgrass community covers from 10% to 15% of the wet meadow units. As the name implies, the most common components are Nevada bluegrass and annual hairgrass. Other commonly found plants include whitetop, desert saltgrass, and silverweed. Coverage by this type is often sparse and bare ground is often present. Because of the elevated sites this type grows on, it is often not flooded or flooded for a very limited period.

The saltgrass-spikerush community covers over 25% of the wet meadow. Common components include desert saltgrass, spikerush, *Atriplex* sp., and poverty weed. This community occurs in areas that retain water late into the spring.

Uplands

There are about 6,500 acres of uplands on Lower Klamath Refuge. Of that acreage, only 850 acres are capable of receiving irrigation. The remainder receives only precipitation. As a result, the vegetation is sparse and typical of the high desert. The irrigated area is maintained in mixed-grass cover.

The unirrigated area is typically vegetated with shrubs and grasses. The overstory is composed of greasewood, gray rabbitbrush, and Great Basin wildrye. The understory is a mixture of grasses including cheatgrass, foxtail barley, and Nevada bluegrass.

Unirrigated uplands offer cover for many species of birds and small mammals. They are used to some extent by waterfowl for nesting, but the primary nesting species are passerine birds and upland game. Unirrigated uplands are also a preferred location for coyote dens. Other common mammals include badgers, jackrabbits, cottontail rabbits, wood rats, and deer mice.

The 850 irrigated acres are vegetated with a mixture of “domesticated” grasses including brome grass, meadow fescue, orchard grass, timothy, and tall wheatgrass. These grasses are burned in midwinter and irrigated in early April. They provide spring migrant sandhill cranes, snow geese,

Ross's geese, cackling Canada geese, Great Basin Canada geese, and several species of ducks including mallard, pintail, and wigeon, with important spring forage.

Irrigated uplands provide spring migrant sandhill cranes, snow geese, Ross's geese, cackling Canada geese, Great Basin Canada geese, and several species of ducks including mallards, pintails, and wigeons with important spring forage. After the area dries in early April, several species of ducks, as well as long-billed curlews, willets, pheasants, short-eared owls, and northern harriers, use the area extensively for nesting. Some fields are traditionally among the highest density waterfowl nesting areas on the refuge.

Fish and Wildlife

Lower Klamath Refuge is the most productive refuge in the Refuge Complex and supports the majority of the species of wildlife occurring on the complex (see Appendix H). Most species occurring on the refuge are dependent on wetlands with waterfowl being the most conspicuous. In addition to waterfowl, the refuge is important to a variety of vertebrate species. Additional details concerning fish and wildlife specific to individual refuges are presented in Sections 5.2 through 5.6 and Appendix H.

Waterfowl and Other Waterbirds

Lower Klamath Refuge stands out for hosting high numbers of waterbirds overall; large numbers of migrant and breeding shorebirds; and important colonies of the eared grebe, American white pelican, great egret, white-faced ibis (one of the largest colonies in the Intermountain West), Franklin's gull (only colony in the Klamath Basin), and Forster's and black terns (Shuford et al. 2004).

The refuge supports one of the densest breeding populations of waterfowl in the NWRS, producing between 30,000 and 60,000 waterfowl annually, as well as producing a variety of colonial nesting water birds (Table 5.12).

Table 5.12. Lower Klamath Refuge Estimated Production of Ducks, Coots, and Geese, 2008 through 2014

Year	*Duck*	*Coot*	*Goose*
2008	20,586	3,863	779
2009	18,964	1,517	440
2010	30,786	6,779	513
2011	10,233	1,421	490
2012	25,495	8,640	462
2013	20,016	6,569	585
2014	8,668	4,552	417
Average	19,250	4,763	527

From 20,000 to 100,000 shorebirds use refuge wetlands during the spring migration, and spring and summer nesting wildlife include many colonial water birds. Wintering wildlife populations include 30,000 tundra swans.

Species that are especially dependent on seasonally flooded wetlands include those listed in Table 5.13.

In permanently flooded wetlands, emergent vegetation provides excellent nesting substrate for many species of waterfowl, wading birds, and passerine birds. It provides excellent cover for resting waterfowl during all seasons of the year by shielding the interspersed areas of open water from the wind. Sago pondweed, found in permanently flooded wetlands, is a primary source of food for tundra swans and several species of ducks. It is of critical importance to migrating canvasback ducks, which feed almost exclusively on sago tubers during their three month stay in the fall. Other species of waterfowl, such as wigeons, scaup, mallards, and coots, consume the vegetative parts and seeds of this and other submergent plants.

Table 5.13. Lower Klamath Refuge Species Especially Dependent on Seasonally Flooded Wetlands

Species	*Migrant Transients*	*Breeding Birds*
Mallard	X	X
Gadwall	X	X
Pintail	X	X
Green-wing teal	X	
Cinnamon teal		X
Shoveler	X	X
Canada goose		X
White-fronted goose	X	
Sandhill crane	X	X
White-faced ibis		X
Black-crowned night-heron		X
Greater egret		X
American avocet		X
Black-necked stilt		X
Short-billed dowitcher	X	
Greater yellow-legs	X	
Lesser yellow-legs	X	
Western sandpiper	X	
Least sandpiper	X	
Dunlin	X	
Semi-palmated plover	X	
Snowy plover		X
Black-bellied plover	X	
Red-winged black-bird		X
Yellow-headed blackbird		X

Source: Service 1994

The submergent plant community also supports a diverse and productive invertebrate community, which is a vital food source eagerly sought by many species of migratory waterfowl and other marsh birds. During the summer months, these invertebrates are a critical food requirement of breeding waterfowl and most ducklings. Breeding eared and western grebes as well as coots use vegetative parts of submergent plants to construct their nests. The floating plant community is composed of a single species, common duckweed. This species is a food source used by coots, rails, and several species of ducks.

Colonial nesting species such as white pelicans, double-crested cormorants, great blue herons, eared grebes, and western grebes use only permanent wetland units for nesting. Not only do these units provide the secure and remote sites they require for nesting, but they provide an abundant supply of fishes these birds need for food. American white pelicans, which nest in

Sheepy Lake (Unit 2), are one of the last two colonies remaining in California (the other being at Clear Lake Refuge) (Shuford et al. 2004).

One of the most critical summer uses of the permanently flooded wetlands on Lower Klamath Refuge is by molting waterfowl. Because these birds are flightless during this period, they need food, water, and cover in close proximity. They seek large permanently flooded marshes for this purpose and the large marshes of the Lower Klamath Refuge are ideal. Ducks have been documented to travel over 300 miles from their nesting areas to these marshes to molt (Service 1994).

A partial list of wildlife species dependent on the permanently flooded wetlands of the Lower Klamath Refuge is provided in Table 5.14.

Wet meadow habitats also provide valuable resources to numerous wildlife species. The Senecio-baltic rush community, although not highly used by waterfowl while flooded, is one of the types most highly utilized for nesting by ducks and other birds. The low grass-forb community, when flooded, is one of the most used types by spring migrant geese, ducks, and swans. Later in the season, it is a preferred nesting site for some shorebird species, such as the long-billed curlew and willet.

Table 5.14. Lower Klamath Refuge Wildlife Species Dependent on the Permanently Flooded Wetlands

Species	*Migrant Transients*	*Breeding Birds*
Mallard	X	X
Gadwall	X	X
Pintail	X	X
Cinnamon teal	X	X
Green-wing teal	X	
Shoveler	X	X
Wigeon	X	
Redhead	X	X
Canvasback	X	X
Lesser scaup	X	X
Ruddy duck	X	X
Eared grebe	X	X
Western grebe	X	X
Pied-billed grebe	X	X
American white pelican		X
Double-crested cormorant		X
Great blue heron		X
Greater egret		X
Black-crowned night-heron		X
Tricolored blackbird		X
Red-winged blackbird		X
Yellow-headed blackbird		X
Sandhill crane		X
River otter		X
Muskrat		X
Western pond turtle		X

Source: Service 1994

Spring use of the bluegrass-hairgrass community is used for nesting by several species of waterfowl. When flooded, there is considerable use of the saltgrass-spikerush community by migrating waterfowl and shorebirds. It offers good brood feeding habitat for early nesting species of ducks and is used extensively by shorebirds, such as avocets and black-necked stilts, for nesting and brood rearing.

Fish

The Ady Canal transports water to the refuge and also carries fish from the Klamath River Basin. Fish can be found in all refuge canals when there is water in the canals. In years when there is sufficient water, two species of chub, two species of other minnows, suckers including two listed suckers (see *Federal and State Listed Species*), catfish, two species of sunfishes, perch, and mosquitofish can occur in the water supply canals and occur on some refuge units (Appendix H). In extremely dry years, when water is limited, there is not enough water to support fish. There are no permanent fish populations on Lower Klamath Refuge.

Federal and State Listed Species

Federally Listed Species

Applegate's milk-vetch

Applegate's milk-vetch is a federally listed plant that potentially occurs on Lower Klamath Refuge given the occurrences within the vicinity, but there are no known modern occurrences. **In a 1995 BiOp (Service 1995) for Reclamation on the Use of Pesticides and Fertilizers on Federal Lease Lands, the Service described Applegate's milk-vetch occurrence in a narrow region restricted to seasonally moist meadows/bunch grass flats near Klamath Falls, Klamath County, Oregon. The specific habitat found supporting these plants is a seasonally moist, lightly vegetated, alkaline grassland community and characterized by poorly drained, alkaline soils (Henley/Malin clay loams). Henley and Malin soil series underlie the Lower Klamath Refuge (Soil Survey Staff 2008). Applegate's milk-vetch is difficult to detect during certain times of the year and so these areas of suitable habitat may actually constitute population sites (Service 1995).**

Lost River sucker and shortnose sucker

The Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*), both federally listed as endangered, are known to occur in Stearns Pond (approximately 5–8 acres) on Lower Klamath Refuge.

The Service currently operates three fish ponds located on Lower Klamath Refuge known **collectively** as the Stearns ponds. The project is to conduct research consistent with the Lost River and shortnose sucker Recovery Plans (**Recovery Action 5, including 5.3 & 5.4)** by developing a "headstart" rearing program to help larval and juvenile Lost River and shortnose suckers survive to adulthood. The program is intended to **increase the resiliency and redundancy of the species** by directly increasing the abundance of suckers in the system that can in turn reproduce and further strengthen their populations, and by providing valuable information on rearing strategies for potential future program development **and improvements**. The first step in the "headstart" rearing program was to collect a relatively small proportion of naturally

produced young fish and relocate them to the Stearns ponds in 2011, where predation by fish and birds can be limited and environmental variability controlled **to some degree** to allow fish to grow and mature before being released at approximately two years of age. Sources of these fish include salvaged individuals from the Klamath Project canal system.

Gray wolf

The endangered gray wolf (*Canis lupus*) **is known to occur within the boundaries of Lower Klamath Refuge.**

State-Listed Species

State-listed birds that have been observed on the refuge are indicated in Appendix H and include: the proposed candidate white-tailed kite (*Elanus leucurus*) (Califorina protected), Swainson's hawk (Oregon sensitive species [Northern Basin and Range Subregion] and California threatened), American peregrine falcon (OSS, California fully protected species, California endangered), bald eagle (Oregon threatened, California endangered), greater sandhill crane (California threatened, California fully protected species) and bank swallow (California threatened), Franklin's gull (*Leucophaeus pipixcan*)(Oregon sensitive species), and California species of special concern: short-eared owl (*Asio flammeus*) tricolored blackbird (*Agelaius tricolor*), and yellow-headed blackbird (*Xanthocephalus xanthocephalus*).

The greater sage-grouse (*Centrocercus urophasianus*) is a state-listed species. In 2005, it was withdrawn as the candidate species for listing under the federal ESA.

Other California Species of Special Concern that have been observed on the refuge include blue chub (*Gila caerulea*) and Sacramento perch (*Archoplites interruptus*).

Bald eagles are the most numerous of the threatened and endangered species on the refuge, with the population of wintering bald eagles peaking at over 1,100 eagles during the winter of 1991-92. Bald eagles begin arriving in November and typically leave by the end of March. They are attracted to Lower Klamath Refuge by large populations of waterfowl and small rodents. The refuge also serves as a major feeding area for bald eagles roosting on the Bear Valley Refuge. In addition to migratory eagles, a small number of nesting pairs of eagles use the refuge as a foraging area during the spring and summer (Service 1995).

Lower Klamath Refuge is one of the most important sites for staging sandhill cranes during fall migration from mid-September to mid-November, when over 1,500 cranes have been counted on a single day (Shuford et al. 2004). The peak counts represent about 15% of the entire Central Valley Population of greater sandhill cranes (Shuford et al. 2004). Fall staging cranes use refuge grain fields for feeding and shallowly flooded seasonal marshes as night roosts.

In addition, cranes use the refuge as a breeding area. A survey on April 8, 2003, recorded 16 adults (6 pairs and 4 individuals) (Shuford et al. 2004).

5.2.3 Cultural Resources

Lower Klamath Refuge is currently listed on the National Register of Historic Places (NRHP) as a Historic District which recognizes it as an early example of an American attempt at preservation

of natural wetlands and wildlife for the future. There are numerous archaeological sites and other cultural resources on the Lower Klamath Refuge, which is located in both rural northeastern California and southern Oregon. According to the *Klamath Basin National Wildlife Refuge Complex Cultural Resources Assessment* (Service 2011a), to date, recorded cultural resources known to be within the congressionally authorized boundaries of the Lower Klamath Refuge consist of 44 recorded prehistoric sites (i.e., worked stone, habitation sites, human remains, groundstone, traditional use locus, bedrock mortars) and 14 recorded historic sites (i.e., historic debris scatters, one NRHP District contributing site, 10 NRHP District contributing structures). A more detailed discussion of the cultural resources within the Refuge Complex is included in Appendix O.

5.2.4 Paleontological Resources

A paleontological resource is defined by the Paleontological Resources Preservation Act (Public Law 111-011) (Omnibus Public Land Management Act of 2009) as any fossilized remains, traces, or imprints of organisms, preserved in or on the earth's crust, that are of paleontological interest and that provide information about the history of life on earth; it does not include archaeological resources or cultural items, which are protected by other laws (see Cultural Resources). Compliance with the Omnibus Act is required for all undertakings funded with federal funds or requiring a federal permit. The Omnibus Act prohibits the collection of paleontological resources from federal land without a permit with the exception of "casual collection" of paleontological resources without a permit on BLM, Reclamation and U.S. Forest Service lands. Accordingly, collection of paleontological resources on refuge land (owned in fee title by the Service) is prohibited. Lower Klamath Refuge has potential to contain paleontological resources but none have been documented.

5.2.5 Visitor Services

Hunting

Waterfowl

The refuge includes lands within California and Oregon, and is currently open for migratory game bird hunting (see Refuge-Specific Regulations for Hunting and Fishing for California at 50 CFR 32.24 and for Oregon at 50 CFR 32.56). The refuge offers a diversity of waterfowl hunting opportunities, including walk-in units, boat-in marsh units (for both motorized and motorless craft), various agricultural fields (e.g., pasture, grain/field crops, and row crops), seven pit blinds (all first come, first served), and uplands. Fields and marshes are free-roam, and there are no spaced blinds that require hunters to check in. An annual lottery is used to select individuals to participate in waterfowl hunting on opening weekend in the California portion of the refuge. There are multiple boat launching sites, designated vehicle access routes, and designated parking areas in the California portion of the refuge. Hunters are not restricted in parking in the Oregon portion of the refuge. Hunters can also drive a street-legal or off-road vehicle off the designated access routes to deploy and retrieve decoys. These drive-in areas provide opportunities for mobility-impaired waterfowl hunters. Such individuals could also reserve a designated boat-in blind in Units 1 and 5 in the California portion of the refuge. Seasons, hours, bag limits, and other rules for waterfowl hunting on the refuge are generally the same as those published annually by the CDFW and the ODFW for hunting of migratory game birds (CDFW 2014; ODFW 2016b).

The hunt zone totals approximately 24,380 acres (Figure 5.5). This area comprises approximately 48% of the almost 51,000 acres under Service management jurisdiction. The remainder of the refuge is closed to waterfowl hunting and serves as a sanctuary area for waterfowl and other wildlife during hunting season. The annual number of waterfowl hunters on the refuge in recent years has varied widely (from approximately 1,500 to 2,600), depending on whether adequate water was available to flood refuge habitats and when the wetlands froze (Klamath Basin Refuge Complex Waterfowl Hunt Surveys for 2010–2011, 2011–2012, and 2012–2013) (Service 2010–2013).

The Lower Klamath Refuge offers a mixture of marsh hunting for both boat-in and walk-in hunters and field hunting for geese and pheasant in both grain stubble and areas of standing grain. Ducks are the most commonly hunted species on Lower Klamath Refuge. The Oregon portion of Lower Klamath Refuge is primarily grain stubble hunting for geese with some ducks taken early in the season or late November/December when some of the fields are flooded. Goose hunting in the field units of the California portion ranges from excellent to fair and varies greatly from year to year. Field units with standing grain are most popular, producing some excellent Canada and white-front goose hunting early in the season and some excellent Canada goose hunting after Christmas. Interior field units can also produce some excellent but sporadic mallard hunting as a bonus.

Sport hunting for waterfowl includes geese, ducks (including mergansers), American coots (*Fulica americana*), and common moorhens (*Gallinula chloropus*), and Wilson's snipe (*Gallinago gallinago*) is allowed on designated areas of Lower Klamath Refuge. Hunting is permitted throughout the California and Oregon seasons. Opening weekend hunts on the California portion of Lower Klamath Refuge are under a draw permit system. Hunting is 7 days per week during the normal state season, however, shoot time ends at 1:00 p.m. on the California portion of the refuge.

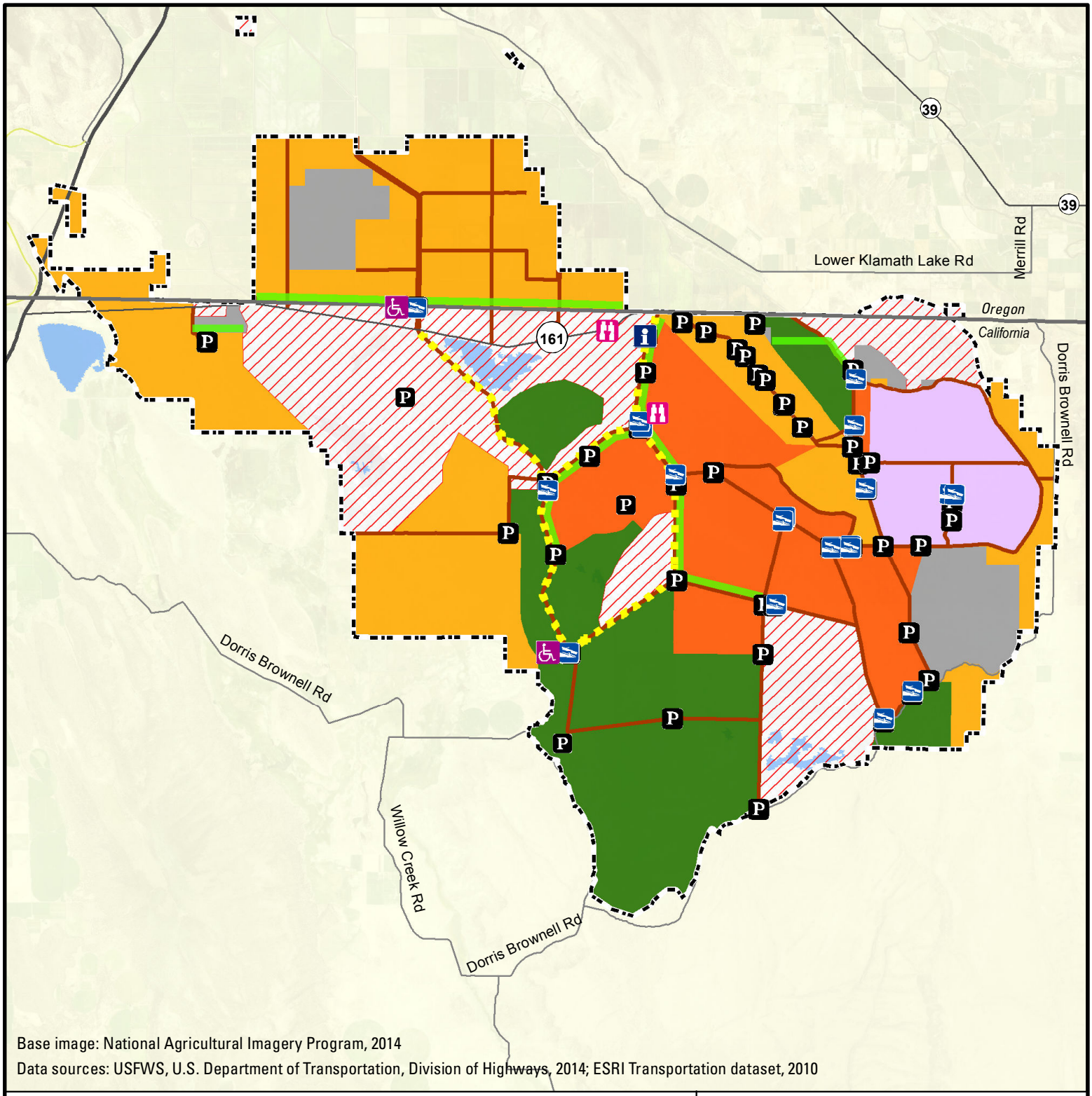
The refuge also conducts an annual youth waterfowl hunt. This special hunt is scheduled by CDFW and ODFW, and usually occurs in mid- to late September (prior to the start of the general waterfowl hunting season) and on selected dates during the regular season. Youths age 15 or younger can participate in this youth hunt provided they are accompanied by an adult (age 18 or over for the California portion of the refuge and age 21 or over for the Oregon portion of the refuge). Adults cannot hunt during this special, pre-season hunt. A special ladies' hunt is also held on the refuge in conjunction with one youth hunt during the regular season. Ladies would be allowed to hunt from 1:00 p.m. until the end of the state's shooting time.

Commercially guided sport hunting for waterfowl is also permitted through a competitive contract and SUPs. Guided sport hunting is conducted in the areas open for that use as determined annually by the Service and described in the SUP. Guides are competitively selected to operate on refuge lands through a formal process. Guide use areas on the refuge are not restricted and include all units open to waterfowl and pheasant hunting.

Upland Game

Sport hunting for ring-necked pheasant (*Phasianus colchicus*) is allowed on designated areas of Lower Klamath Refuge during the state-regulated hunting season. CDFW regulations allow some upland game to be hunted with shotguns, bow and arrow (archery), and falconry (hawk or falcon). A SUP is required for this use.

Parking areas are located across the refuge and hunter access to individual fields is walk-in only. A hunter information site building (check station) is located in the main entrance of the refuge.



Base image: National Agricultural Imagery Program, 2014

Data sources: USFWS, U.S. Department of Transportation, Division of Highways, 2014; ESRI Transportation dataset, 2010

- Approved acquisition boundary
- Auto tour route
- Refuge road
- Hunter retrieval area
- Private inholding
- Wildlife observation
- Visitor information
- Designated parking area
- Hunt blinds - accessible to mobility impaired
- Boat launch
- Waterfowl hunting only
- Pheasant hunting only
- Waterfowl & pheasant hunting
- Pheasant & rotating waterfowl hunting (up to 50% open to waterfowl on an annual basis)
- Hunting prohibited

Figure 5.5. Visitor Services Lower Klamath Refuge

0 0.75 1.5 3 miles

Pheasant hunting is permitted daily during the regulated season. Shooting times in designated areas on the refuge correspond to state regulations. Pheasant hunting on the refuge begins at 8:00 a.m. Season dates, hours, harvest limits, and other rules for hunting on the refuge are the same as those published annually by the CDFW for hunting of upland game (CDFW 2014). The refuge does not participate in the two 2 archery-only pheasant hunts.

Pheasant hunting is limited to the units of the refuge as designated on the pheasant hunting map (see Figure 5.5). Approximately 9,227 acres of the refuge are open to pheasant hunting. This area comprises approximately 18% of the 50,092 acres within the refuge. The remainder of the refuge is closed to pheasant hunting. The annual number of pheasant hunters on the refuge in recent years has been relatively stable, averaging 45 hunters and 58 birds on opening day (Klamath Basin Refuge Complex Upland Game Hunt Surveys for 2009–2010, 2011–2012, and 2014–2015) (Service 2009–2015).

Wildlife Observation, Photography, and Interpretation

Wildlife Observation

The Lower Klamath Refuge is open to the public for wildlife observation and photography daily along the auto tour route, vehicle pull-offs, and wildlife overlook from sunrise to sunset year-round. The auto tour route is a 14.8-mile loop located 12.0 miles from the Refuge Complex Visitor Center. It is accessed from State Line Road (aka Highway 161). The only parking area open to the general public during non-hunting season along the auto tour route is the viewing kiosk located at the main entrance off of Highway 161. Here visitors can get general information from kiosks and walk to the wildlife viewing platform on the Lower Klamath Refuge. The other parking areas along the auto tour route are designated for waterfowl hunting.

Photography

In addition to the photography opportunities at the wildlife viewing platform and the auto tour route, there is one photo blind on the refuge. This is the Lower Klamath Eagle Snag Blind. This is a newly constructed, two-person blind located near a dead tree where eagles and raptors perch in the late fall and winter. From the Refuge Complex Visitor Center the blind is accessed by driving 3.9 miles north on Hill Road to the intersection with State Line Road (Highway 161). Turn left onto State Line Road and continue 11.2 miles. Visitors should park just off the highway on the left at the chain link fence. Hike approximately 600 yards along the dike to the blind on the dike top located near a dead tree where eagles and raptors perch in the late fall and winter. The blind is approximately 75 feet from the perching location. A minimum 300mm telephoto lens is recommended. This blind has two viewing ports facing the raptor tree and three additional ports for other opportunities and is situated for morning photography of eagles and raptors. The best season for photography of eagles is from mid-December through mid-March.

Use of this blind is by reservation only on a first-come, first-served basis and accepted only within 3 months of the first date the blind will be used. Just one blind may be reserved per day, and a given blind may be reserved for up to 2 days per week. An annual Recreation pass is required for anyone using the photo blind. Visitors may reserve this blind in person at the Refuge Complex Visitor Center, by telephone, or mail. Reservations made by telephone or mail should be made at least 10 days prior to intended use so that reservation materials will arrive by mail prior to use. Reservation confirmations are mailed when payment has been received. A season pass is available

for $25.00 ($12.50 for those with the Golden Age, Senior Interagency or Interagency Access Pass). Full-time students also qualify for the half price passes. Reservation materials ask visitors to conduct their activities so as to keep wildlife disturbance to a minimum. Photographers are encouraged to enter blinds at or prior to sunrise (this blind must be accessed prior to 07:00 a.m.) which reduces disturbance and helps achieve the best results.

Interpretation

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. Nature interpretation at the Lower Klamath Refuge is provided at the entrance kiosks where brochures, maps, and visitor information is provided to the public; through interpretive signs along the auto tour route; through periodic staff-led nature programs; and through the Service website where current resource information is provided. Interpretation may expand in the future by providing additional staff-led interpretive programs; a contact station at the entrance of Lower Klamath Refuge for visitor orientation; by providing hands-on exhibits at the visitor center; by updating brochures; and by updating the visitor center entrance to be more visitor friendly and compliant with the Americans with Disabilities Act.

Guided Wildlife Observation, Photography, and Interpretation

Permittee(s) are allowed to conduct commercial tours of either a for-profit or non-profit educational nature, and are allowed in public use areas where appropriate. The focus of these tours may include wildlife observation, photography, and interpretation. Commercial tours may take from 1 day to multiple days and may involve multiple tour periods throughout the year as stated in the SUP.

<u>Environmental Education</u>

The Refuge Complex has developed a kindergarten through 12th grade birding curriculum and a kindergarten through 8th grade wetlands curriculum that is the basis for lessons that are taught on-site and are specific to each refuge within the Refuge Complex. Although most of the learning takes place at the Lower Klamath and Tule Lake Refuges, there are lessons that include curriculum about all the refuges in the complex. Students are taught at the Dave Menke Education Center, which is a converted duck hospital across the street from the visitor center, on the Discovery Marsh Trail, Sheepy Ridge Trail, Lower Klamath and Tule Lake auto tours, and the visitor center. About four times a year students are taught on the Canoe Trail at the Upper Klamath Refuge. Students are currently using only areas that are open to all public use. Currently the refuge is providing on-site education to approximately 1,500 students annually and works with approximately 15 local schools including charter schools, public schools, community organizations, etc.

The Refuge Complex provides off-site education to approximately 1,000 students annually at a variety of locations including the 6th grade forestry tour on BLM land in southern Oregon, and other local parks and federal lands. The 6th grade forestry tour is a combination of education stations and partners; the event runs every 6th grade class through the lessons over a 3-day period.

Boating

Boating on Lower Klamath Refuge consist of car-top, hand-launched boats, such as kayaks and canoes; boats with electric motors; and motorized boats powered by 2-cycle or 4-cycle (4-stroke) gasoline engines. Air-thrust and inboard water-thrust (jet) boats are prohibited.

Boats may be used on all wetland units open to waterfowl hunting. The refuge is open to boating during the waterfowl hunt season from posted entry time to 2:30 p.m. Boat launching is not permitted after 1:00 p.m. and all boats must be removed from waterfowl hunt areas by 2:30 p.m.

Twenty boat launches across the refuge provides access to the marsh units. In designated marsh units, boating is limited to motorless boats or boats with electric motors only until December 1. Beginning December 1, these units open to motorboat use as well. All state boating requirements are enforced by refuge officers.

A yearly recreation pass is required to boat on Lower Klamath Refuge. Boaters may pay in person at refuge headquarters or in advance with a credit card by phoning refuge headquarters (530)-667-2231 or online at: https://klamathbasinrecreation.com. All fees collected are kept at the Refuge Complex refuges and are used to improve the hunt program. Annual recreation passes are $25.00 ($12.50 for those with the Golden Age, Senior Interagency or Interagency Access Pass). Full-time students also qualify for the half price passes. Boaters must carry their recreation pass at all times in the field.

The portion of the refuge open to boating totals approximately 23,173 acres. This area comprises approximately 45% of the almost 51,000 acres under Service management jurisdiction. The remainder of the refuge is closed to boating and serves as a sanctuary area for waterfowl and other wildlife during hunting season.

Regulation of boating on the refuge is managed to minimize safety risks, as well as adverse effects on wildlife, habitat, and other recreational users, particularly those engaged in wildlife-dependent uses.

5.2.6 Management and Monitoring Practices

Habitat/Water Management

Because of flood control, drainage, and control of fire on Lower Klamath Refuge, the natural timing and duration of many of the forces that historically shaped the marsh no longer occur. Wetland managers must now manipulate these forces (e.g., fire, flooding, and drainage) and use other tools to affect wetland succession on the refuge, thereby providing for a variety of vegetative communities and their associated wildlife species. Current habitat management on the Lower Klamath Refuge is dependent on Reclamation's Klamath Project for its supply of water. All of its water is essentially delivered through a system of diversion or irrigation canals.

Lower Klamath Refuge has been divided into a number of management units ranging from 63 acres to over 4,000 acres. Water in these units is manipulated to meet refuge purposes and goals as set forth by the establishing orders and the Kuchel Act. Many of the management units on the refuge are managed under a rotational management scheme that incorporates a variety of disturbance factors. This has proven the most efficient method of maintaining wetland

productivity and the desired juxtaposition of different wetland habitats. Because of the rotational management and variability of water supplies, each habitat type will occupy a range of acreages.

Seasonally Flooded Wetlands

Seasonally flooded wetlands are managed for moist soil and a diversity of emergent wetland plants, with an emphasis toward red goosefoot, smartweed, and hardstem bulrush. This habitat type is very important to fall and spring migrant waterfowl and shorebirds.

Normal management of seasonally flooded wetlands requires flooding of the habitat unit during the early fall to early winter and then dewatering the unit in late spring to early summer by gradually lowering the water level either by draining, evaporation, or a combination of both. This water management develops a productive wetland habitat that can be optimally used by migratory waterfowl and other wildlife. The slow draw down of water during the growing season results in the development of a complex mosaic of vegetative communities. This results from the uneven bottom contour being dewatered by a declining plane of water. As these "patches" of the bottom are dewatered, they warm and the plant seeds in them germinate. Since these patches are drying out at slightly different times of the spring, a specific plant association develops on each of them and results in a "patchwork" of differing plant associations in the unit.

Several key plant communities are the object of seasonally flooded wetland water management. Most provide excellent production of seeds, and the foliage supports excellent substrate for the development of invertebrate life. Both the seeds and the invertebrates are critical food items for migrating and breeding waterfowl, shorebirds, and other marsh birds.

Seasonally flooded marshes have a finite productive life. The units generally evolve to a largely monotypic stand of alkali bulrush scattered with clumps and patches of hardstem bulrush and cattail. When the marsh reaches this level of plant succession, its ability to provide food and resting sites for migrating waterfowl, shorebirds, and sandhill cranes is greatly diminished. Unless the seasonally flooded wetland is to be retained for breeding habitat for waterfowl and other wetland species, a management change is usually implemented at this point. A number of options may be used.

The spring drawdown may be accelerated to allow mechanical control (disking or plowing) of the offending alkali bulrush stands and encourage the production of the desirable food plants, such as smartweed and goosefoot. Alternatively, the unit could be returned to cereal grain farming for a period, thus eliminating all natural wetland plants in the unit. After the farming period, a return to the seasonally flooded wetland water management regime would result in very productive early succession wetland. A third alternative would be to manage the unit as a permanently flooded wetland. Year-round flooding would eliminate all the seasonal marsh plants except hardstem bulrush and cattail and develop a submergent plant community as well. This management option could be used only if a sufficient summer water supply is available and the unit does not have a history of avian botulism.

Permanently Flooded Wetlands

Permanently flooded wetlands are managed for a diverse emergent and submergent plant community with hardstem bulrush and sago pondweed the preferred plant species. The target emergent/open water interspersion ratio is between 30% and 70% of either type. This habitat type

is maintained by flooding year-round and is important to diving ducks. Refuge wetlands are intensively managed to provide for an interspersion of successional stages.

Similar to seasonally flooded wetlands, farming for cereal crops may be used to set back succession in a marsh unit. By draining and farming former marsh units, all vestiges of unwanted vegetation can be eliminated and then desirable plants can be reestablished with seasonal water management regimes resulting in a more productive wetland.

Wet Meadow

Normal management of wet meadow requires that flooding commence in the winter months, usually starting in mid-December and continuing through March, and then evaporate dry in April and early May. Since these units have no water supply except small streams fed by runoff from the immediate basin, the duration and amount of annual flooding is highly variable from year to year and the vegetative response is equally variable.

Agriculture

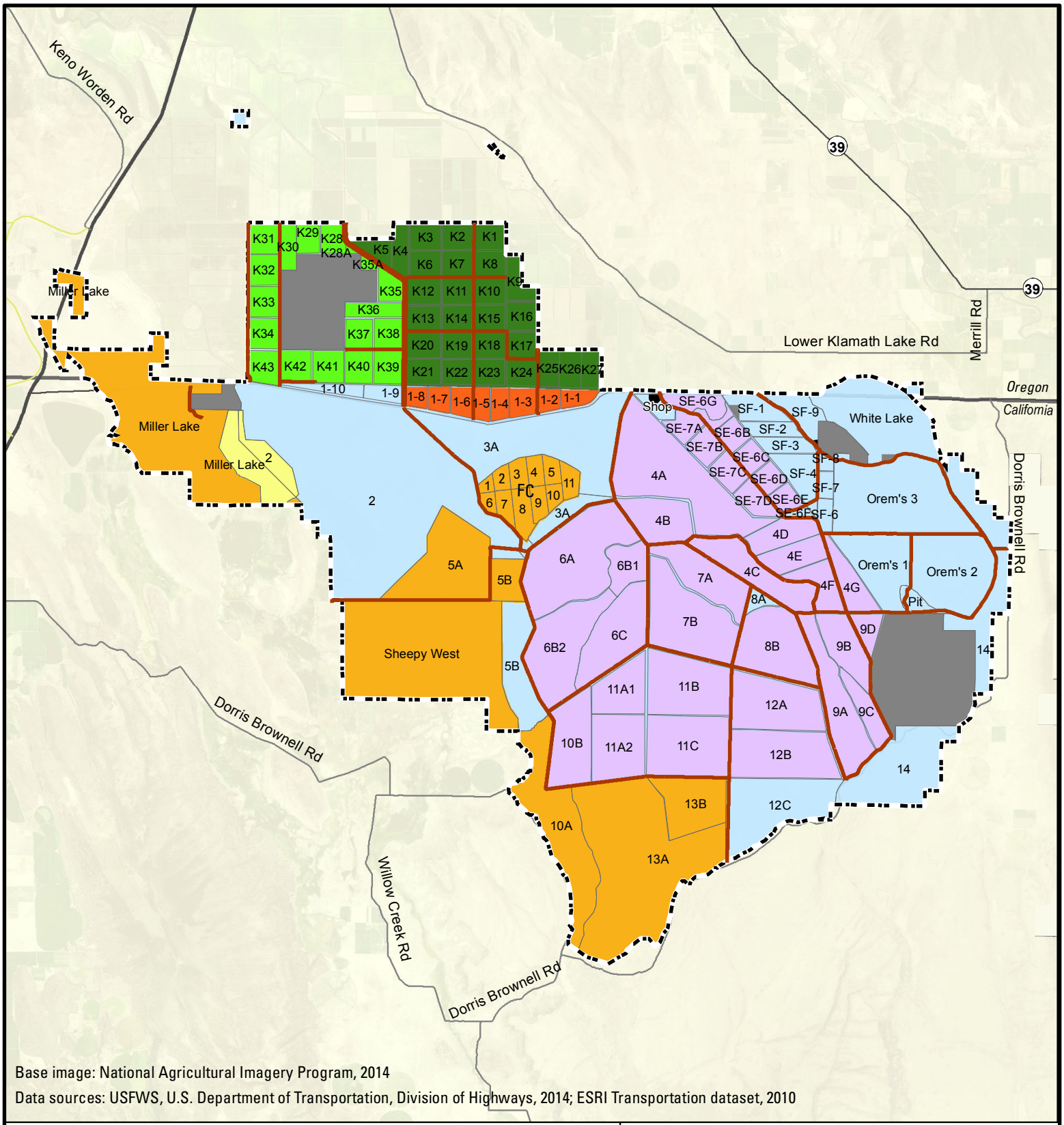
Besides water management, the refuge uses sharecrop farming on 3,000 to 5,000 acres, haying on 200 acres, livestock grazing on 7,300 acres, and prescribed burning on 15,000 acres to maintain its wetlands in a variety of successional stages. Figure 5.6 illustrates the areas were cooperative and lease land farming and grazing can occur on Lower Klamath Refuge.

Acres farmed by refuge cooperating farmers are dedicated exclusively to cereal grain (usually barley) production. The farmer is allowed to harvest three-quarters of the crop in consideration of his expense and labor for tilling, seeding, and fertilizing the crop. The one-fourth the farmer is not allowed to harvest is left standing in the field for the benefit of wildlife. The farmer provides all seed, fertilizer, pesticide, equipment, fuel, and labor while the Service provides the land, water, and irrigation services. These fields are normally flood irrigated only once, in early winter, and dewatered in early spring in preparation for planting. No additional irrigation during summer is used. Cooperatively farmed lands used for cereal grain production are subject to infestation by competing "weeds" such as quackgrass, mustard, pepperweed, and *Bassia* sp. To control those species, farmed fields are subjected to permanent flooding for a period of 18 months every 5 to 8 years. During that period, these units develop dense and productive beds of sago pondweed and receive high use by many species of waterfowl, as previously discussed in the section on permanently flooded wetlands.

In addition to providing grain to fall migrant waterfowl and sandhill cranes, farming is used as a tool to maintain a series of units in an early successional stage. These units provide maximum production of moist soil seed plants (seasonal marshes) and sago pondweed (open submergent).

Haying

Haying is permitted on refuge lands, including the cutting, drying/curing, raking, bailing, temporary storage (stacking of bales), and removal of vegetation (including plant heads, leaves, and stems), usually for livestock fodder. The most common plants hayed on the refuge include pasture grasses, rushes, and sedges. There have been haying programs on the refuge for decades. In recent years, approximately 200 acres in the western portion of the refuge (i.e., Miller Lake and Unit 2) and 1,765 acres in the northern (Oregon) portion of the refuge (i.e., Area K, the Oregon



Base image: National Agricultural Imagery Program, 2014

Data sources: USFWS, U.S. Department of Transportation, Division of Highways, 2014; ESRI Transportation dataset, 2010

- Approved acquisition boundary
- Refuge road
- Private land
- Developed
- Wetland habitat
- Lease land farming
- Lease land haying & grazing
- Cooperative grazing
- Cooperative haying & grazing
- Cooperative farming
- Cooperative farming/ wetland rotation

Figure 5.6. Lease Land and Cooperative Agriculture - Lower Klamath Refuge

0 1 2 4 miles

Straits Unit, or the Klamath Straits Unit) have been hayed annually. This area comprises approximately 4% of the almost 51,000 acres under Service management jurisdiction.

Haying is conducted, along with other management techniques such as grazing, mowing, and prescribed fire, to help achieve habitat and associated wildlife objectives. An example objective could be to introduce an environmental disturbance event by using haying to open up dense emergent or other vegetation, to set back vegetative succession, and thereby enhance habitat for foraging and breeding birds and other wildlife. Because the emergent wetland habitat over much of the refuge is closely packed with vegetation, it is logistically difficult to accomplish small fires to open up the wetlands (Service 2008). Therefore, the other habitat management techniques likely would be used more frequently. The mixture, acreage, locations, and timing of management techniques used during any particular year is based on an assessment of current and likely future habitat conditions and wildlife needs, including the potential availability of water; the availability of adequate funding, staff, and equipment; air quality restrictions; the availability of local farmers, ranchers, and livestock; forage quality; and site conditions (e.g., access, roughness of the terrain, fencing, and other infrastructure).

Haying requires use of a variety of farm machines on the refuge (potentially including tractors, swathers/windrowers, hay rakes, hay balers, and trucks) and the personnel to operate these machines. Personnel are on site as needed throughout the season to monitor the field(s)/crop(s) and perform appropriate farming-related functions, including operating the machines. Some or all of these machines are on the refuge throughout the season.

Haying on the refuge is conducted through use of a variety of administrative/legal means.

On the lease land units in Area K, consistent with the cooperative agreement between the Service and Reclamation, haying is conducted under leased-land contracts between Reclamation and a private farmer(s) (Service and Reclamation 1977). These contracts describe what is to be done, when, where, and how; and include incentives. These contracts also include numerous conditions associated with this work, addressing for example, genetically engineered crops; fire management; transport, storage, and disposal of fertilizers, fuel and other petroleum products, pesticides, and other hazardous materials; management of pests and waste; and hazing waterfowl and other wildlife. Reclamation administers the leased-land program on the refuge including, for example, solicitation of bids, contract management, monitoring of compliance with and enforcement of lease contracts, lease extensions and terminations, and collection and deposit of rents. Consistent with the National Wildlife Refuge System Administration Act, the Service retains ultimate administrative control of all activities on the refuge, including leased-land farming.

Lease Land Grazing

Grazing is permitted on refuge lands with domestic livestock, primarily cattle (*Bos primigenius*), but possibly including goats (*Capra aegagrus hircus*) and/or sheep (*Ovis aries*). Grazing has occurred intermittently on the refuge for decades. In recent years, 1,280 acres (1,280 animal-unit-months [AUMs]) in the northern (Oregon) portion of the refuge (i.e., Area K, the Oregon Straits Unit, or the Klamath Straits Unit) have been grazed through the lease land program annually (see Figure 5.6 for areas grazed through the lease land program in recent years). This acreage comprises less than 3% of the almost 51,000 acres within the approved refuge boundary. There are two types of grazed lots in Area K. Post-haying fall-pasture lots are grazed from September through November and permanent pasture lots are grazed from June through November.

Currently only two small lots of less than 30 acres each are permanently grazed. It is expected that approximately the same acreage in the same areas of the refuge would be grazed through the leased-land program in future years, although drought and the lack of irrigation water could reduce the acreage grazed. Grazing in the Area K Unit generally follows in those areas that have been hayed earlier in the season.

Plants grazed are primarily grasses, including a preponderance of quackgrass (*Agropyron repens*) and meadow foxtail (*Alopecurus pratensis*). Other species grazed include broadleaf cattail (*Typha latifolia*); grasses (e.g., barley [*Hordeum* spp.], bent grasses [*Agrostis* spp.], bluegrasses [*Poa* spp.], and saltgrass [*Distichlis spicata*]); rushes (e.g., alkali [*Schoenoplectus maritimus*] and hardstem [*Schoenoplectus acutus*] bulrushes, and *Juncus* spp.); sedges (e.g., *Carex* spp. and spike sedges [*Eleocharis* spp.]); a mixture of forbs; and similar species. Invasive plants such as reed canarygrass (*Phalaris arundinace*a), crested wheatgrass (*Agropyron* spp.), and perennial pepperweed (*Lepidium latifolium*), are also targeted for grazing.

Lease land grazing would continue to be conducted, along with other management techniques such as haying, mowing, and prescribed fire, to help achieve habitat and associated wildlife objectives. These management techniques would be applied to benefit foraging and breeding waterfowl, other water birds, and other wildlife. Lease land grazing and the other habitat management techniques, as appropriate, would continue to be used on varying acreages and be rotated around different parts of the refuge to ensure that a diversity of habitat types, qualities, and successional stages were always available for use by refuge wildlife. The mixture, acreage, locations, and timing of management techniques used during any particular year would be based on an assessment of current and likely future habitat conditions and wildlife needs, including the potential availability of water; the availability of adequate funding, staff, and equipment; air quality restrictions; the availability of local farmers, ranchers, and livestock; forage quality; and site conditions (e.g., access, roughness of the terrain, fencing, and other infrastructure).

Grazing involves the use of a variety of equipment and infrastructure on the refuge, including trucks, trailers, off-road vehicles, horses, dogs, loading/unloading ramps, corrals, barns, water pumps, off-stream watering facilities, and temporary (likely electric) and permanent (including barbed-wire) fences and gates; and the personnel to operate these machines and manage the livestock. Ranching personnel are on site as needed throughout the season to manage the livestock and perform appropriate ranching-related functions, including fence maintenance, providing and positioning any watering facilities and mineral blocks, and operating the equipment. Some or all of this equipment could be on the refuge throughout the season.

Grazing on a refuge can be conducted through use of a variety of administrative/legal means. As evaluated herein, and consistent with the cooperative agreement between the Service and Reclamation, grazing would be pursued under a lease land contract between Reclamation and a private rancher(s) (Service and Reclamation 1977). These contracts describe what is to be done, when, where, and how; and include incentives (potential lease extensions) for selected grazing practices. These contracts also include numerous conditions associated with this work, addressing for example, genetically engineered crops; fire management; transport, storage, and disposal of fertilizers, fuel and other petroleum products, pesticides, and other hazardous materials; management of pests and waste; and hazing waterfowl and other wildlife. Reclamation administers the leased-land program on the refuge including, for example, solicitation of bids, contract management, monitoring of compliance with and enforcement of lease contracts, lease extensions and terminations, and collection and deposit of rents. Consistent with the National

Wildlife Refuge System Administration Act, the Service retains ultimate administrative control of all activities on the refuge, including leased-land grazing. Grazing is considered an economic use under federal regulations. The Service may authorize economic use by appropriate permit only when the use on a refuge has been determined to be compatible (50 CFR 29.1).

As noted above, the Kuchel Act states, in part, that Lower Klamath Refuge is to be managed for wildlife conservation and "…for the major purpose of waterfowl management, but with full consideration to optimum agricultural use that is consistent therewith." Additionally, this act states that, "The Secretary [of the U.S. Department of the Interior] shall, consistent with proper waterfowl management, continue the present pattern of leasing the reserved lands…within the Executive Order boundaries of the Lower Klamath and Tule Lake National Wildlife Refuges…." The grazing area was leased for grazing and other agricultural uses for many years prior to passage of the Kuchel Act (Service 1956, as cited in Appendix M).

Cooperative Grazing

Cooperative grazing is permitted on refuge lands with domestic livestock, primarily cattle, but possibly including goats and/or sheep. Grazing has occurred regularly on the refuge for decades. In recent years, approximately 11,225 acres (3,670 AUMs) in the western, central, and southern areas of the refuge (i.e., Units 2, 3B, 5A, 10, and 13A; Miller Lake; and Sheepy West) have been grazed annually (see Figure 5.6 for areas grazed in recent years). This acreage comprises approximately 22% of the almost 51,000 acres under Service management jurisdiction. It is expected that approximately the same acreage in the same areas of the refuge would be grazed in future years. However, depending on evolving habitat/wildlife needs and the feasibility of using other habitat management techniques, the remainder of the refuge (except White Lake and Unit 3A, which were not included as irrigated units under the Service's 1905 agricultural water right) would be considered for grazing in the future (totaling perhaps 2,000–3,000 additional acres/year).

Plants grazed include broadleaf cattail (*Typha latifolia*); grasses (e.g., barley [*Hordeum* spp.], bent grasses [*Agrostis* spp.], bluegrasses [*Poa* spp.], and saltgrass [*Distichlis spicata*]); rushes (e.g., alkali [*Schoenoplectus maritimus*] and hardstem [*Schoenoplectus acutus*] bulrushes, and *Juncus* spp.); sedges (e.g., *Carex* spp. and spike sedges [*Eleocharis* spp.]); a mixture of forbs; and similar species. Invasive plants such as reed canarygrass (*Phalaris arundinacea*), crested wheatgrass (*Agropyron* spp.), and perennial pepperweed (*Lepidium latifolium*), are also targeted for grazing. All of these species grow on the refuge without the need for planting, irrigation, fertilization, or pest management/pesticide use.

Grazing would continue to be conducted, along with other management techniques such as haying, mowing, and prescribed fire, to help achieve habitat and associated wildlife objectives described in this CCP for the refuge. An example objective could be to introduce an environmental disturbance event by using grazing to open up dense emergent or other vegetation, to set back vegetative succession, and thereby enhance habitat and wildlife diversity. This could benefit foraging and breeding waterfowl, other water birds, and other wildlife. In an effort to develop biologically sound management plans for waterfowl during fall through spring, the period when waterfowl use is highest on Lower Klamath Refuge, a Strategic Habitat Conservation approach was developed to design, implement, and monitor management actions on Lower Klamath and adjacent Tule Lake Refuges. The plan: A Bioenergetic Approach to Conservation Planning for Waterfowl at Lower Klamath and Tule Lake National Wildlife Refuge was completed in 2008 in partnership with Ducks Unlimited and Oregon State University (Dugger et al. 2008). Aerial waterfowl survey

data from 1990 through 1999 were used to establish population objectives for geese and swans at either refuge and 1970 through 1979 data were used to develop duck and coot population objectives. Conservation planning for migrating and wintering waterfowl is based on the fundamental premise that food is the resource limiting population performance. Under the plan, 75% of food resources for each guild were to come from refuge lands versus adjacent private lands. An analysis of food resources on Lower Klamath Refuge determined that in order to meet goose energy needs in winter and spring, unharvested grain acreage would need to expand from 1,000 to 1,500 acres and green browse would need to increase from 2,000 to 4,000 acres. Grazing is the best method to provide the needed increased acres in green browse forage. Grazing and the other habitat management techniques, as appropriate, would continue to be used on varying acreages and be rotated around different parts of the refuge to ensure that a diversity of habitat types, qualities, and successional stages were always available for use by refuge wildlife. The mixture, acreage, locations, and timing of management techniques used during any particular year would be based on an assessment of current and likely future habitat conditions and wildlife needs, including the potential availability of water; the availability of adequate funding, staff, and equipment; air quality restrictions; the availability of local farmers, ranchers, and livestock; forage quality; and site conditions (e.g., access, roughness of the terrain, fencing, and other infrastructure). Depending on precipitation and irrigation, grazing could occur from late spring through the middle of the winter.

Grazing would involve the use of a variety of equipment and infrastructure on the refuge, potentially including trucks, trailers, off-road vehicles, horses, dogs, loading/unloading ramps, corrals, barns, water pumps, off-stream watering facilities, and temporary (likely electric) and permanent (including barbed-wire) fences and gates; and the personnel to operate these machines and manage the livestock. Ranching personnel would be on site as needed throughout the season to manage the livestock and perform appropriate ranching-related functions, including fence maintenance, providing and positioning any watering facilities and mineral blocks, and operating the equipment. Some or all of this equipment could be on the refuge throughout the season.

Grazing on a refuge can be conducted through use of a variety of administrative/legal means. As evaluated herein, grazing would be pursued under a SUP issued by the Service (see Administration of Specialized Uses, 5 RM 17) or under a cooperative land management agreement (CLMA) with the Service (see Cooperative Land Management [50 CFR 29.2]). Under a SUP, a rancher would pay the Service, on an AUM basis, to graze a particular location(s) on a refuge for a specified period of time. AUM fees would be based on local fair market values or set through a bidding process. A CLMA is a "share-in-kind" agreement. Under a CLMA, a rancher would perform work in aid of or benefit to wildlife management of a refuge in exchange for the privilege to graze livestock. The value of the work performed would be less than or equal to the value of the AUMs grazed. The rancher would pay the Service for any AUMs received in excess of the work performed. Grazing on the refuge is currently not administered through a CLMA.

Lease Land Farming

Lower Klamath Refuge lease lands (Area K) are located on the north edge of the refuge on the Oregon side of the California/Oregon state boundary. The lease lands are consolidated in a single block of land devoted primarily to waterfowl management and commercial crop production. Pursuant to the 1977 Cooperative Agreement between the Service and the Reclamation, this area is leased by Reclamation on a competitive bid basis. Leases are for 5 years with an annual option to renew with the same approximate percentages of new leases and renewals as on Tule Lake.

Area K consists of 43 individual lots ranging from 102 to 160 acres each for a total of 6,254 acres. Primary agricultural practices include grazing, haying, and the growing of barley, oats, and wheat. All lease lots are pre-irrigated from November through January with water removed from February through March. Planting of small grains is generally completed by early June. Because of the high water-holding capacity of the soils, no summer irrigation is required for small grains. Hay and pasture lands undergo additional flood irrigation in summer. The Ady Canal supplies water to the federal lease lands in Area K, west of the Klamath Straits Drain. Lots east of the Klamath Straits Drain are supplied water by the Center Canal, and are managed for small grain production and "winter irrigated" (i.e., continuously flooded) from January through March, although some lots may receive a pre-irrigation in the fall. Thereafter, lots are drained and seedbed preparation starts in 4 to 6 weeks when soil moisture allows field operations. Typically, no additional irrigation is used during the growing season. Drains in both locales are fed by laterals located on the edge of lots and overflow from canals. Post-irrigation drainage laterals may hold irrigation water that has not been evacuated by gravity, water associated with the water table, or rainfall.

Cooperative Farming

The Service manages a cooperative farming program on the refuge to provide small grains (wheat, barley, and oats) for migratory birds. A variety of management techniques are used on the refuge cooperative farmlands to combat pests and help ensure successful crop yields. These techniques include pre-plant flood irrigation, rotation of crops, pre-plant tilling, pre-plant prescribed burning, and the application of pesticides. These are the primary practices used as the Service pursues an IPM approach to farming and pest management on the refuge.

Cooperative farmers are allowed to use the same suite of pesticides on the same crops and pests with the same best management practices (BMPs) as those used by individuals farming the lease lands on the refuge (see Service and Reclamation 2015). Table 5.15, below, summarizes the types of pesticides used or proposed for use on the refuge cooperative farmlands in recent years (i.e., 2011–2015). Between 2011 and 2015, less than 1,000 acres each year were chemically treated for pest control as part of the cooperative farming program on the refuge, as shown in Table 5.16.

Table 5.15. Lower Klamath Refuge Cooperative and Lease Land Farmlands: Crops, Pests, and Pesticides

Pest			*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Wheat, barley, oats	Five-hook bassia	*Bassia hyssopifolia*	WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Banvel; MCP Amine 4, Rhomene MCPA	2,4-D dimethylamine; dicamba dimethylamine; MCPA dimethylamine
Wheat, oats	Five-hook bassia	*Bassia hyssopifolia*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba dimethylamine
Barley	Five-hook bassia	*Bassia hyssopifolia*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba
Wheat, barley, oats	Flixweed	*Descurainia sophia*	WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Banvel; MCP Amine 4, Rhomene MCPA	2,4-D dimethylamine; dicamba dimethylamine; MCPA dimethylamine
Wheat, oats	Flixweed	*Descurainia sophia*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba dimethylamine

Table 5.15. Lower Klamath Refuge Cooperative and Lease Land Farmlands: Crops, Pests, and Pesticides

Pest			*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Barley	Flixweed	*Descurainia sophia*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba dimethylamine
Wheat, barley, oats	Lambsquarters	*Chenopodium album*	WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Banvel; MCP Amine 4, Rhomene MCPA	2,4-D dimethylamine; dicamba dimethylamine; MCPA dimethylamine
Wheat, oats	Lambsquarters	*Chenopodium album*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba dimethylamine
Barley	Lambsquarters	*Chenopodium album*	Clarity, Banvel, Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba
Wheat, barley, oats	Prickly lettuce	*Lactuca serriola*	WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Banvel; MCP Amine 4, Rhomene MCPA	2,4-D dimethylamine; dicamba dimethylamine; MCPA dimethylamine
Wheat, oats	Prickly lettuce	*Lactuca serriola*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba dimethylamine
Barley	Prickly lettuce	*Lactuca serriola*	Clarity; Banvel; Dicamba Max 4	Dicamba; dicamba diglycolamine; dicamba
Wheat, barley, oats	Redroot pigweed (common amaranth)	*Amaranthus retroflexus*	Weedar 64, WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Banvel, Dicamba Max 4; MCP Amine 4, Rhomene MCPA; Clarity	2,4-D dimethylamine; dicamba dimethylamine; MCPA dimethylamine; dicamba diglycolamine
Barley	Quackgrass	*Elymus repens*	Roundup PowerMAX	Glyphosate

Table 5.16. Lower Klamath Refuge Pesticide Use in Cooperative Farming Units

Year	Pesticide Use Grain (gallons)	Pesticide Use Row Crops (gallons)	Total Pesticide Use (gallons)	Total Acres Treated
2011	88.172	No row crops allowed	88.172	942
2012	222.75	No row crops allowed	222.75	724
2013	70.25	No row crops allowed	70.25	688
2014	0.0	No row crops allowed	0.0	0.0
2015		No row crops allowed		Reported annually in December

Fire Management

Fire is a force that historically occurred in the Lower Klamath Lake ecosystem. Wildfire, however, is no longer acceptable on Lower Klamath Refuge. Wildfire has the potential of escaping the refuge and placing private property and human lives at risk. In its place, managers use prescribed fire.

Burning is used in a variety of ways on Lower Klamath Refuge. As a stand-alone tool, it is used in wetlands and uplands. Prescribed fire in wetlands opens up dense stands of emergent vegetation, thereby creating open water areas for use by fall and spring migrant waterfowl. Shallow flooded burn areas are also used extensively by shorebirds during spring migration and as night roosts by

sandhill cranes. Flooded burns warm quickly in the spring and are heavy producers of aquatic invertebrates, key food items of spring migrant ducks and shorebirds. Although fire is useful for creating openings in dense stands of emergent plants, this effect is short-lived as these plants resprout quickly from below the ground in the subsequent spring. Long-term control requires follow-up treatments of disking or plowing.

Prescribed fire in uplands invigorates grass nesting cover for waterfowl and other ground-nesting birds and creates green browse for spring migratory geese. Fire in upland habitats reduces brush species and increases the proportion of an area in grasses and forbs.

Burning is also used to remove residual vegetation prior to farming operations. Removal of residual vegetation ensures a clean seed bed for optimal production of small grains.

Prescribed fire on Lower Klamath Refuge is conducted by trained and experienced personnel following national and regional fire policies. Burn plans are written for each fire and include goals of the burn, manpower needs, environmental conditions (wind speed, humidity, etc.), and safety considerations.

Mechanical Control of Vegetation

Disking and plowing are used (usually in conjunction with burning) to remove emergent vegetation from wetland units, thereby increasing the proportion of open water in the habitat. Removing emergent vegetation also creates sites for moist soil seed plants in seasonal wetlands and submergent plants in permanently flooded wetlands.

Herbicides

Herbicides are routinely used to reduce noxious/exotic weeds from wetland and upland habitats, and control roadside vegetation aiding road maintenance. The primary target plant species are poison hemlock, perennial pepperweed, Canada thistle, bull and Scotch thistle, and purple loosestrife. All herbicides are applied by trained applicators.

Pesticides are applied using hand wands or backpack sprayers; boomless sprayers mounted on all-terrain vehicles, utility-terrain vehicles, or trucks; and occasionally from aircraft (e.g., for large habitat rehabilitation/improvement projects, like control of perennial pepperweed in association with rehabilitation of Fairchild Island). In recent years (2011–2014), approximately 690 to 3,630 acres have been chemically treated annually for invasive species control on the refuge. An acre was counted each time it was treated with a pesticide. If the same acre was treated twice with the same or a different pesticide, it was counted as 2 acres treated. If it was treated three times with the same or a different pesticide, it was counted as 3 acres treated, etcetera. The actual number of refuge acres that were treated with any pesticide at all, regardless of the number of times or the pesticides used, is unknown.

Pesticide applications are evaluated and permitted consistent with the DOI and Service IPM and other relevant policies, and pesticide use proposals (PUPs). Table 5.17, below, summarizes the types of pesticides used or proposed for use to control invasive species as described in the wildlife, habitat, and facilities management programs in recent years (i.e., 2011–2015). A summary of pesticides applied for invasive species management and facility maintenance is provided in Table 5.18.

Table 5.17. Lower Klamath Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

	Invasive Species		*Pesticide*	
Habitat/Facility Type	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Parking lot or roadside	Five-hook bassia	*Bassia hyssopifolia*	Krovar I DF; Banvel; Vanquish	Bromacil + diuron; dicamba dimethylamine; dicamba acid
Parking lot or roadside, riparian	Five-hook bassia	*Bassia hyssopifolia*	Habitat, Ecomazapyr 2 SL, Polaris, Polaris AC; Gly Star Original	Imazapyr; glyphosate
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Five-hook bassia	*Bassia hyssopifolia*	E-2	2,4-D dimethylamine + fluroxpyr + dicamba
Meadow or pasture, and range	Five-hook bassia	*Bassia hyssopifolia*	Weedmaster	2,4-D dimethylamine + dicamba dimethylamine
Aquatic and wetland	Five-hook bassia	*Bassia hyssopifolia*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Parking lot or roadside	Downy brome	*Bromus tectorum*	Krovar I DF	Bromacil + diuron
Parking lot or roadside, riparian	Downy brome	*Bromus tectorum*	Gly Star Original	Glyphosate
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Common cocklebur	*Xanthium strumarium*	E-2	2,4-D dimethylamine + fluroxpyr + dicamba
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Poison hemlock	*Conium maculatum*	Weedar 64; E-2	2,4-D dimethylamine; 2,4-D dimethylamine + fluroxpyr + dicamba
Meadow or pasture, and range	Poison hemlock	*Conium maculatum*	Weedmaster	2,4-D dimethylamine + dicamba dimethylamine
Parking lot or roadside, and riparian	Yellow iris	*Iris pseudacorus*	Habitat, Ecomazapyr 2 SL, Polaris, Polaris AC	Imazapyr
Parking lot or roadside	Lambsquarters	*Chenopodium album*	Krovar I DF; Banvel; Vanquish	Bromacil + diuron; dicamba dimethylamine; dicamba acid
Parking lot or roadside, riparian	Lambsquarters	*Chenopodium album*	Gly Star Original; Habitat, Ecomazapyr 2 SL, Polaris, Polaris AC	Glyphosate; imazapyr
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Lambsquarters	*Chenopodium album*	E-2	2,4-D dimethylamine + fluroxpyr + dicamba
Meadow or pasture, and range	Lambsquarters	*Chenopodium album*	Weedmaster	2,4-D dimethylamine + dicamba dimethylamine
Meadow or pasture, and range	Prickly lettuce	*Lactuca serriola*	Weedmaster	2,4-D dimethylamine + dicamba dimethylamine
Aquatic and wetland	Purple loosestrife	*Lythrum salicaria*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Parking lot or roadside, riparian	Purple loosestrife	*Lythrum salicaria*	Habitat, Ecomazapyr 2 SL, Polaris, Polaris AC	Imazapyr

Table 5.17. Lower Klamath Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

	Invasive Species		*Pesticide*	
Habitat/Facility Type	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Grassland, meadow or pasture, parking lot or roadside, and range	Common mullein	*Verbascum thapsus*	Milestone Specialty, Milestone VM	Aminopyralid
Aquatic and wetland	Common mullein	*Verbascum thapsus*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Meadow or pasture, and range	Common mullein	*Verbascum thapsus*	Milestone Specialty, Milestone VM	Aminopyralid
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Black mustard	*Brassica nigra*	E-2	2,4-D dimethylamine + fluroxpyr + dicamba
Disturbed area, grassland, meadow or pasture, range, and riparian	Perennial pepperweed	*Lepidium latifolium*	Telar XP, Telar DF; Habitat, Ecomazapyr 2 SL	Chlorsulfuron; imazapyr
Disturbed area, meadow or pasture, parking lot or roadside, and range	Perennial pepperweed	*Lepidium latifolium*	AquaMaster, AquaNeat, Rodeo, Roundup PowerMAX, Roundup PROMAX, Ranger Pro, Alecto 41S	Glyphosate
Parking lot or roadside, and riparian	Perennial pepperweed	*Lepidium latifolium*	Habitat, Ecomazapyr 2 SL, Polaris, Polaris AC	Imazapyr
Aquatic and wetland	Phragmites or common reed	*Phragmites australis*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Parking lot or roadside	Redroot pigweed	*Amaranthus retroflexus*	Krovar I DF; Banvel; Vanquish;	Bromacil + diuron; dicamba dimethylamine; dicamba acid
Parking lot or roadside, and riparian	Redroot pigweed	*Amaranthus retroflexus*	Gly Star Original; Habitat, Ecomazapyr 2 SL, Polaris, Polaris AC	Glyphosate; imazapyr
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Redroot pigweed	*Amaranthus retroflexus*	E-2	2,4-D dimethylamine + fluroxpyr + dicamba
Meadow or pasture, and range	Redroot pigweed	*Amaranthus retroflexus*	Weedmaster	2,4-D dimethylamine + dicamba dimethylamine
Parking lot or roadside	Puncturevine	*Tribulus terrestris*	Krovar I DF	Bromacil + diuron
Parking lot or roadside	Common purslane	*Portulaca olearacea*	Krovar I DF	Bromacil + diuron
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Bull thistle	*Cirsium vulgare*	Weedar 64; E-2	2,4-D dimethylamine; 2,4-D dimethylamine + fluroxpyr + dicamba
Grassland, meadow or pasture, parking lot or roadside, and range	Bull thistle	*Cirsium vulgare*	Transline; Milestone Specialty, Milestone VM	Clopyralid; aminopyralid
Meadow or pasture, and range	Bull thistle	*Cirsium vulgare*	Milestone Specialty, Milestone VM; Weedmaster	Aminopyralid; 2,4-D dimethylamine + dicamba dimethylamine
Grassland, meadow or pasture, parking lot or roadside, and range	Canada thistle	*Cirsium arvense*	Transline; Milestone Specialty, Milestone VM	Clopyralid; aminopyralid

Table 5.17. Lower Klamath Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

	Invasive Species		*Pesticide*	
Habitat/Facility Type	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Disturbed area, grassland, meadow or pasture, range, and riparian	Canada thistle	*Cirsium arvense*	Telar DF, Telar XP	Chlorsulfuron
Disturbed area, meadow or pasture, parking lot or roadside, and range	Canada thistle	*Cirsium arvense*	AquaMaster, AquaNeat, Rodeo, Roundup PowerMAX, Roundup PROMAX, Ranger Pro, Alecto 41S	Glyphosate
Meadow or pasture, and range	Canada thistle	*Cirsium arvense*	Milestone Specialty, Milestone VM; Weedmaster	Aminopyralid; 2,4-D dimethylamine + dicamba dimethylamine
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Scotch thistle	*Onopordum acanthium*	Weedar 64; E-2	2,4-D dimethylamine; 2,4-D dimethylamine + fluroxpyr + dicamba
Grassland, meadow or pasture, parking lot or roadside, and range	Scotch thistle	*Onopordum acanthium*	Transline; Milestone Specialty, Milestone VM	Clopyralid; aminopyralid
Meadow or pasture, and range	Scotch thistle	*Onopordum acanthium*	Milestone Specialty, Milestone VM; Weedmaster	Aminopyralid; 2,4-D dimethylamine + dicamba dimethylamine
Disturbed, grassland, meadow or pasture, range, and riparian	Yellow starthistle	*Centaurea solstitialis*	Telar DF, Telar XP	Chlorsulfuron

Table 5.18. Lower Klamath Refuge Pesticide Application for Invasive Species Management and Facility Maintenance

Year	*Acreage*
2011	3,639
2012	1,300
2013	652
2014	808

Prior to pre-irrigation, refuge grain fields (Service cooperators) are checked for utilization. Ocular estimates of the proportion of standing grain consumed are made. This survey ensures that the acreage of grain matches the needs of migratory waterfowl.

Pest control on lease lands is handled through the 1998 *Integrated Pest Management Plan and Environmental Assessment for Leased Lands at Lower Klamath and Tule Lake National Wildlife Refuges, Oregon/California* (IPM Plan) (Service 1998a). The lease land farming program is administered by Reclamation for the Service (Service and Reclamation 1977). Up to 25% of the lease land area may be planted to row crops. However, only small grains, pasture, and grass hay are grown on Lower Klamath Refuge. The lease land farming program as applied to Lower Klamath Refuge is described in the IPM Plan (Service 1998a). A component of the IPM Plan is the use of a PUP to authorize the application of pesticides on the refuge. A PUP is a concise document that describes the type of chemical proposed for use, the pest intended for control, the general treatment site, and any sensitive areas near the treatment site that may need special attention.

The PUPs that authorize the use of pesticides on the lease lands are prepared at the beginning of the agricultural season after review by the Lease Land PUP Committee. The list of pesticides that have been used or proposed for use on agricultural land between 2011 and 2015 is summarized above in Table 5.16. These pesticides are authorized specifically for agricultural use whether on lease lands or cooperative farm units. Although up to 100 PUPs may be authorized each year, less than half of the approved pesticides are used. The refuge tracks the application of pesticides for agricultural use at a Refuge Complex level based on the use numbers submitted by the farmers to the County Extension Service. Table 5.19 provides a summary of the acreage of pesticide application on agricultural land from 2008 through 2014. Because these PUPs are tracked at the Refuge Complex level, the numbers below represent application on lease lands (up to 22,000 acres) at both the Lower Klamath and Tule Lake Refuges. The variation in the pesticide application is partially due to the availability of water and weather condition. For example, in 2010, much of the land was fallowed which allowed weeds to grow, resulting in additional pesticide applications the following years. In addition, wet springs increase the number and type of pests that must be controlled.

Table 5.19. Summary of Pesticide Application Acreage for Lower Klamath and Tule Lake Refuges Lease Lands, 2008 through 2014

Year	*Acreage Applied*
2008	53,342
2009	63,362
2010	31,220
2011	62,879
2012	67,475
2013	96,691
2014	78,793

Fish and Wildlife Management

Vegetation Monitoring

Refuge biologists map vegetative communities in selected marsh units each year. Priorities are placed on those units undergoing rapid change or those in which habitat modification may be implemented.

Vegetative maps have several functions. First, when mapping is done over several years, the maps provide a successional history for each management unit, and photo documentation of habitats that have resulted from a particular set of management activities. Additionally, vegetative maps allow managers to determine if habitat goals are met.

Photo points, transects, or simple ocular estimates are periodically performed following upland burns. This is necessary to evaluate whether burning goals are met. These goals are generally burn-specific but usually involve either removal of brush species and/or stimulation of grasses or forbs and/or a wildlife use goal. For example, burning of grasses may be conducted to increase spring goose use on resprouting grass.

Burned or burned/disked areas in wetlands are visited after flooding to determine if the burn accomplished goals pertaining to creation of open water emergent interspersion. Burned/disked

areas are also checked the following growing season to determine to what degree emergent vegetation has been replaced by moist soil plant communities.

Wildlife Monitoring

Aerial bird surveys are conducted two times per month from September through April, and bird numbers are recorded by management unit. Species counted include all waterfowl, bald eagles, sandhill cranes, and white pelicans. In addition, Point Reyes Bird Observatory periodically conducts spring and fall shorebird surveys on selected units of the refuge. These counts are important as they assist refuge managers in determining timing of wetland drawdowns for shorebird use. Additional surveys include waterfowl pair counts, waterfowl brood surveys, colonial waterbird surveys, tricolored blackbird surveys, and others. These data in conjunction with the biologist's judgment are used in determining whether wildlife use is meeting goals for a particular habitat. Table 5.20 summarizes the period of record, frequency, and timing of current and historic surveys on Lower Klamath Refuge.

Disease Monitoring

Waterfowl diseases are a major concern on Lower Klamath Refuge. Similar to other monitoring activities, disease data are collected by management unit. Ultimately, this information is used to determine if particular management activities precipitate disease outbreaks or if certain geographical areas are prone to disease.

Table 5.20. Lower Klamath Refuge Current and Historic Surveys

Survey Name	*Start Year*	*End Year*	*Frequency of Survey*	*Survey Timing*	*Status*
Breeding Canada Goose Pairs	1950	Indefinite	Recurring - every year	Mid-March	Current
Breeding Duck Pairs Survey	1950	Indefinite	Recurring - every year	Mid-May	Current
Breeding Sandhill Cranes	1990	Indefinite	Recurring - every year		Current
Colonial Waterbird Surveys	1970	Indefinite	Recurring - every year	Methods and timing depend on the species	Current
Fall Sandhill Crane Staging Survey	1983	Indefinite	Recurring - every year	September–November	Current
Fall Staging Waterbird Survey	2011	Indefinite	Recurring - every year	Mid-August	Current
Mid-Winter Waterfowl Survey	1960	Indefinite	Recurring - every year	Early January	Current
Nongame Waterbird Breeding Population Survey	2011	Indefinite	Recurring - every year	Mid-June	Current
Periodic Waterfowl Surveys	1950	Indefinite	Recurring - every year	September–April	Current
Secretive Marshbird Surveys	2011	Indefinite	Recurring - every year	May–July	Current
Spring Shorebird Survey	2011	Indefinite	Recurring - every year	Late April	Current
Tule Goose Fall Survey	1995	2012	Recurring - every year	September	Historic
Tricolored Blackbird Survey		Indefinite			Current
Vegetation Mapping	1992	Indefinite	Recurring - every year	August–September	Current
Water Records	1970	Indefinite	Recurring - every year		Current
Wintering Raptor Surveys	2011	Indefinite	Recurring - every year	January–February	Current
Wintering Tule Goose Survey	2000	Indefinite	Recurring - every year	October and November	Current

5.3 Clear Lake National Wildlife Refuge

5.3.1 Physical Environment

Geographic Setting

Clear Lake Refuge is located in northern California, just south of the Oregon border in Modoc County. The 20,000-acre Clear Lake Reservoir surrounded by high desert is the dominant feature of this 33,401-acre refuge (see Figure 1.4). The refuge is bounded by Modoc National Forest lands with the public lands of the Lava Beds National Monument to the southwest.

Geology

The lake occupies a broad, flat alluvial basin in barren volcanic terrain.

Soils

In the Clear Lake Refuge, soils occurring between the rock land outcrops have course pumice sand surface layers and subsoils (Service 2001). However, due to the volcanic nature of the area most soils are shallow over fractured basalt and contain compacted layers and hardpans (Service 2001). Low sagebrush and annual and perennial grasses are the dominant plants of this soil type. The majority (68%) of this refuge is open water. Adjacent to the shoreline of the impoundment, deeper soils of a sandy loam texture are present (Figure 5.7). Big sagebrush and Great Basin wildrye are found on these sites.

The following six soil typs comprise 6% of the refuge.

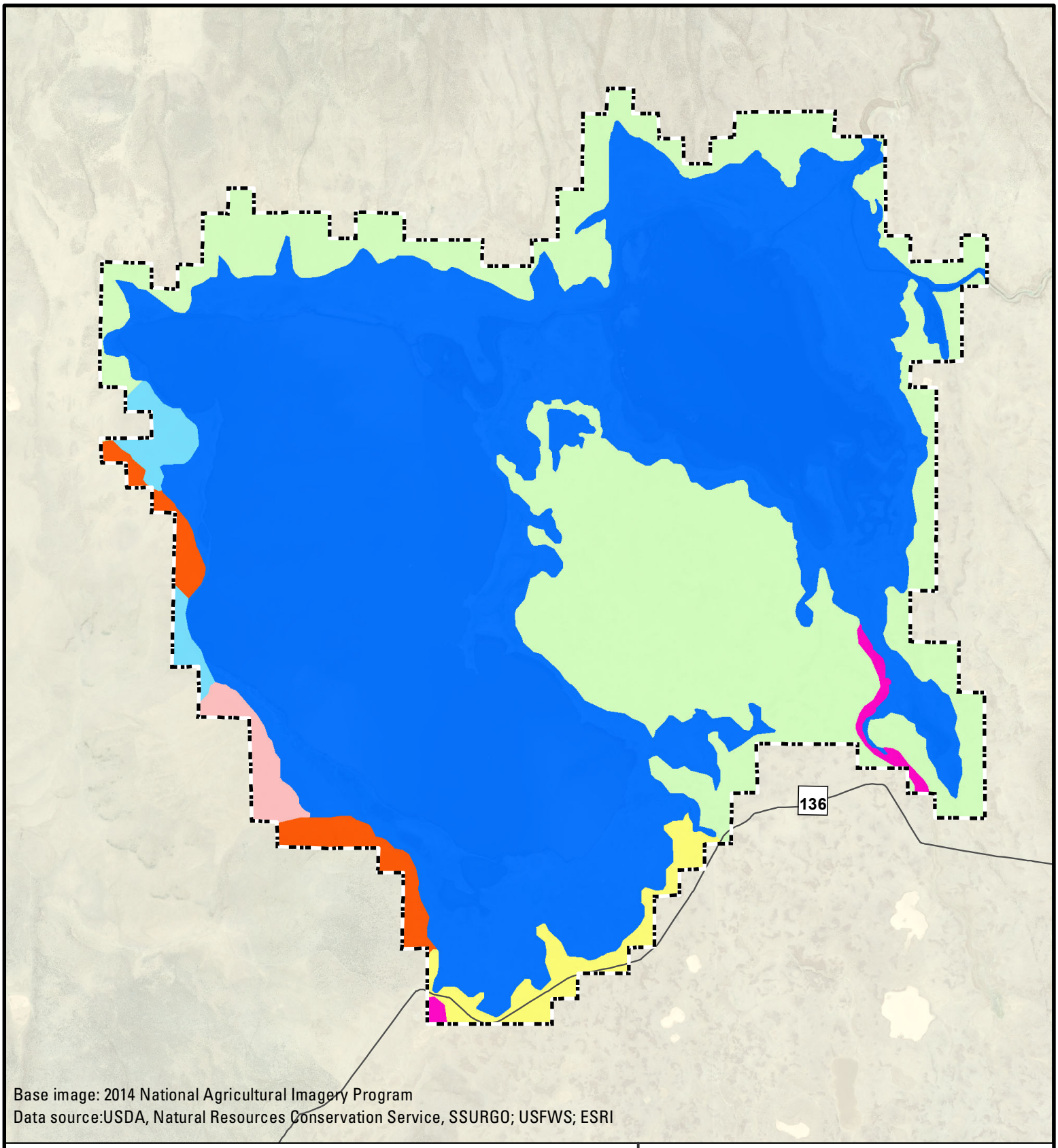
Puls: Puls soils are nearly level to moderately sloping and are on nearly level to gently rolling hummocky plateaus. They formed in place from basalt, andesite flow rock, or tuff. These are well-drained soils with slow or medium runoff and very slow permeability. These soils are suitable for rangeland. The Puls soils comprise 26% of the refuge.

Cardon: The Cardon series consists of very deep, somewhat poorly drained soils. Cardon soils occur on nearly level low lake terraces. Slope gradients are 0% to 3%.

Cowiche: The Cowiche series consists of deep, well-drained soils formed in loess and residuum on uplands. Slope gradients are 0% to 70%.

Indian Creek: Indian Creek soils are on high stream terraces and dissected fan remnants. These soils formed in alluvium derived from mixed igneous rocks. Slopes are 0% to 15%. These soils are well drained with very high surface runoff. Indian Creek soils are suitable for livestock grazing, recreation, urban development, and wildlife habitat.

Stukel: The Stukel series consists of shallow, well-drained soils that formed in residual material weathered from tuff, diatomite, and other volcanic rocks. Stukel soils are on hills, lava plains, and on rock benches and have slopes of 0% to 40%. These soils are suitable for livestock grazing and irrigated crops.



Base image: 2014 National Agricultural Imagery Program
Data source:USDA, Natural Resources Conservation Service, SSURGO; USFWS; ESRI

Approved acquisition boundary

Water

Soil type

- Cardon family
- Cowiche family
- Indian Creek-Puls-Barnard families complex
- Puls-Roval-Dishner families complex
- Stukel-Los Gatos pas canyon families complex
- Wrentham-Bakeoven families association

Figure 5.7. Soils - Clear Lake Refuge

0 0.5 1 2 miles

Wrentham: The Wrentham series consists of moderately deep, well-drained soils that formed in loess mixed with colluvium weathered from basalt. Wrentham soils are on north-facing canyon slopes and have slopes of 35% to 70%. These soils are suitable for rangeland.

Wind-based erosion potential on Clear Lake Refuge is very low. The majority of the refuge is ranked 0 and a small portion of the refuge is ranked 1 or 2 (Figure 5.8). The exception is the 550 acres (1.6%) of Stukel soils located near the Peninsula. This soil type is more susceptible to wind-based erosion with a rank of 4.

Hydrology

Clear Lake was a natural lake that existed prior to construction of the Clear Lake Dam, which was constructed between 1908 and 1910 to prevent flows into and flooding of Tule Lake such that the lake bed could be reclaimed for irrigation purposes. Clear Lake Dam was purposefully designed and located to provide for maximum evaporation and seepage to get rid of water, as much of the Klamath Project area had too much water to be effectively farmed at that time. The dam lies at the head of the Lost River, which flows northward from California into Oregon. With construction of the dam, total capacity of the lake is 526,770 acre-feet of storage with a corresponding surface area of 25,760 acres.

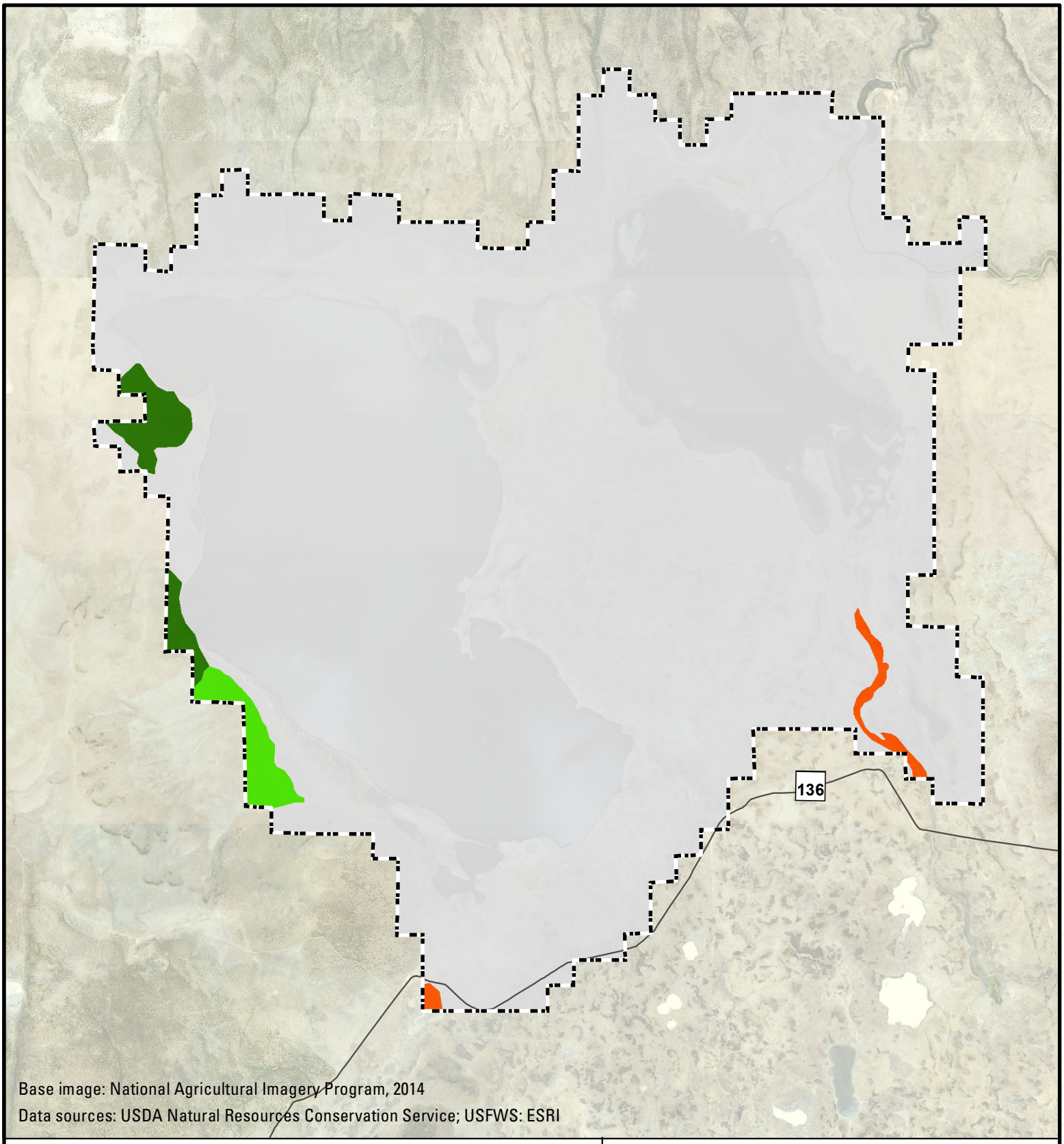
Clear Lake Dam is operated by Reclamation to provide benefits for irrigation, flood control, and wildlife habitat. Stored water released from Clear Lake Dam provides a primary irrigation supply to approximately 10,896 acres in the Langell Valley Irrigation District, Horsefly Irrigation District, and private landowners in Langell Valley under individual contract with Reclamation. Water is impounded by Clear Lake Dam which prevents downstream flooding of the historic Tule Lake, thereby allowing agricultural use of about 17,500 acres of reclaimed lands.

Reservoir operations are conducted in accordance with the Standing Operating Procedures for Clear Lake Dam and the May 2013 BiOp on Operation of the Klamath. Under that opinion, the reservoir is operated by Reclamation to assure a minimum surface elevation of 4,520.6 feet on October 1 annually. A large mesh barrier net was installed in the lake around the dam outlet works to restrict juvenile and adult suckers from leaving the lake during the irrigation season.

Water Quality

Much of the Lost River watershed upstream of Clear Lake is publicly owned under the jurisdiction of the U.S. Forest Service (Modoc National Forest) and the Service (Clear Lake Refuge). The condition of the watershed is relatively good because the management focus of the two agencies is on water quality and habitat protection (Service 2002b). The State of California removed the Section 303(d) listings for the Upper Lost River (above Clear Lake) in 2006; therefore, the Upper Lost River in California is not currently listed as water quality impaired.

Since 1991, water quality conditions in Clear Lake have been generally good over a range of water levels and years, but low dissolved oxygen conditions have been observed during late summer in the east lobe of Clear Lake near the outlet when lake levels are low and water depth is shallow (Reclamation 1994, 2001, unpublished data). These low dissolved oxygen conditions near the outlet occur infrequently and persist for short durations (Reclamation 2007). There have been no reported fish die-offs in Clear Lake Reservoir (Service 2002b). Since 2002, the minimum lake level requirement has been 4,520.6 feet, which is higher than in 1992 when poor fish health was observed (Reclamation 1994). The May 2013 BiOps from the NMFS and the Service indicate that the proposed minimum elevation for Clear Lake continues to be 4,520.60 feet (NMFS and Service



Base image: National Agricultural Imagery Program, 2014

Data sources: USDA Natural Resources Conservation Service; USFWS: ESRI

Approved acquisition boundary

Soil Erodibility (scaled, low to high)	% of total area
0	97.5
1	1.2
2	0.9
3	0.4
4	0
5	0
6	0

Figure 5.8. Soil Erodibility from Wind - Clear Lake Refuge

0 0.5 1 2 miles

2013). Further, lower water levels may result in degraded water quality, particularly higher water temperatures and lower dissolved oxygen. However, water quality monitoring over a wide range of lake levels and years documented water quality conditions that were adequate for sucker survival (Reclamation 1994, 2001, 2007).

Fire History

Eleven wildfires have burned on Clear Lake Refuge between 1936 and 2015. The remoteness of the refuge has affected the types of wildfires experienced over the years. Only one fire has been confirmed as being started by equipment usage, while most wildfires were naturally started by lightning.

The areas surrounding the lake are covered in a combination of western juniper, sagebrush, and cheatgrass. The volatility of these light, flashy fuels coupled with pattern winds often results in large acreages being rapidly consumed. The fires of the 1930s originated from the Modoc National Forest and burned onto the refuge, as did more recent fires. In July 2015, a lightning strike ignited a wildfire on 7.5 acres of refuge lands. For more details on the fire history of Clear Lake Refuge and the associated effects on vegetation, see "Old Burns" under the Vegetation and Habitat Resources section below.

5.3.2 Biological Resources

Vegetation and Habitat Resources

Clear Lake Refuge is currently 46,460 acres. It consists of Clear Lake, a reservoir of approximately 20,000 acres of open water and small islands, and the surrounding uplands (Figure 5.9a).

Uplands

Included in refuge uplands is the "U," a 5,500-acre peninsula stretching northwest into the lake, dividing it into two narrowly connected lobes west and east. Shoreline habitats are composed largely of bunchgrasses, low sagebrush, and juniper.

In 2009 the major vegetation zones on the "U" were mapped using a Trimble Geo XM GPS unit. The mapping was done when the surface of the lake was at 4,525 feet elevation resulting in the "U" covering approximately 4,500 acres. The three vegetation zones were shoreline (2,400 acres), sagebrush (1,050 acres), and non-sagebrush or old burns (1,050 acres).

Shoreline

When the lake is low as it was in 2009, the amount of shoreline is greatly increased. Because the lake elevation fluctuates so much, over time sagebrush cannot establish in the shoreline zone of the lake and invasive plants such as cheatgrass and medusahead (*Taeniatherum caput-medusae*) tend to colonize those areas. Currently the shoreline vegetation consists primarily of forbs, and perennial and annual grasses. Over the past 25 years, the lake elevation has fluctuated approximately 20 feet from 4,520 feet elevation in late summer of 1992 to 4,539 feet elevation in the spring of 1986. In the past 5 years, the highest lake elevation reached was in the spring of 2006, when the lake was over 4,532 feet. Generally, the shore vegetation consists primarily of

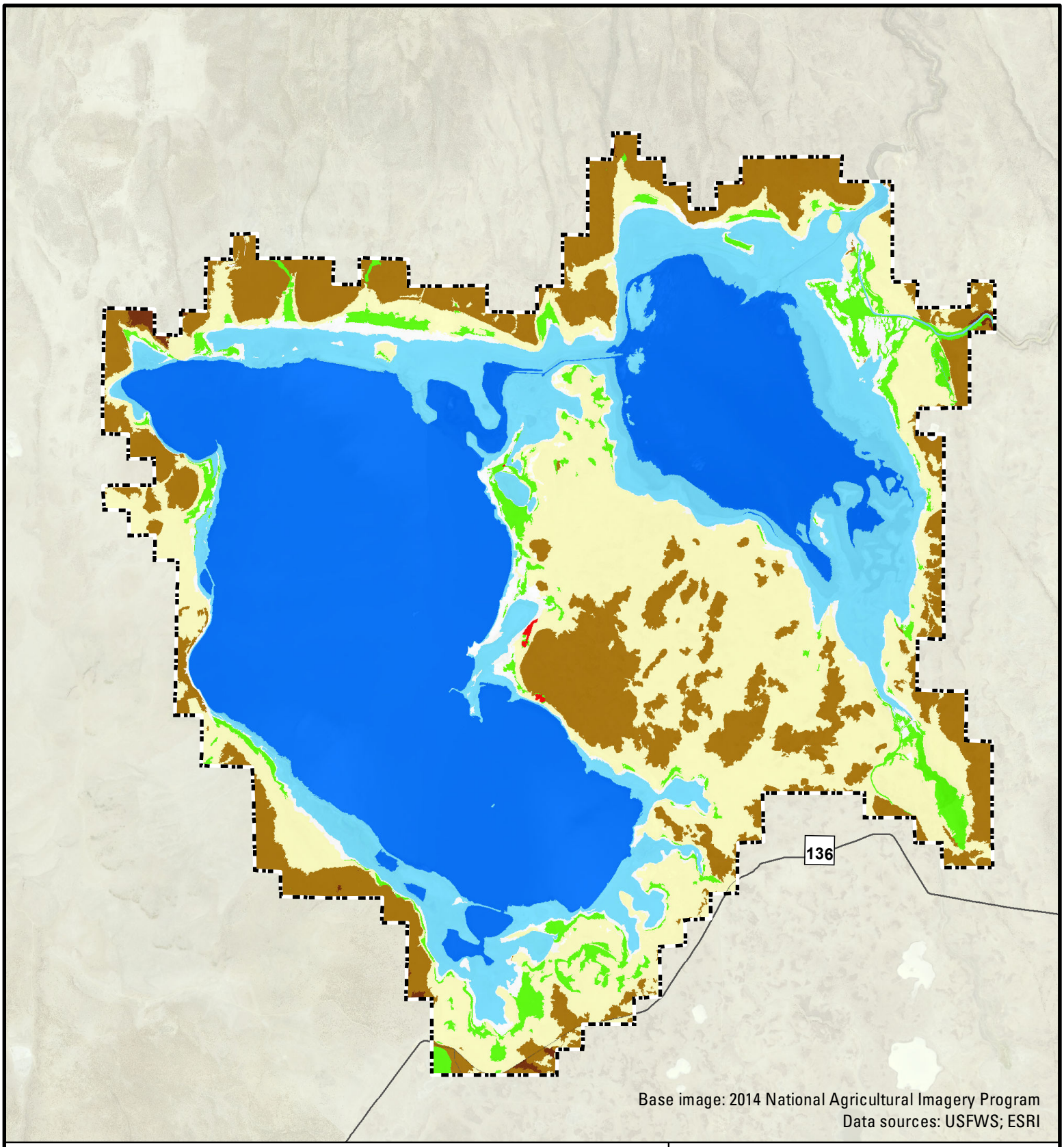


Figure 5.9a. Vegetation - Clear Lake Refuge

forbs, some annual grasses, and patchy perennial grasses. Common active shoreline forbs include clover (*Trifolium* sp.), Lemmon's milk vetch (*Astragalus lemmonii*), Modoc hawksbeard (*Crepis modocensis*), Purshe's milk vetch (*Astragalus purshii*), Great Basin Lomatium (*Lomatium simplex*), false buckwheat (*Erigonum sphaerocephalum*), and low everlasting (*Antennaria dimorpha*). The upper shore contains a moderate level of perennial grasses like squirreltail (*Elymus elymoides*) mixed with patches of invasive annual grasses and several species of forbs (i.e., *Epilobium* spp., dwarf lupine, *Lupinus lepidus*). The shore is mostly free of any shrubs except in some areas along the western shore of the "U" where willows (*Salix* spp.) do exist in small isolated patches.

Sagebrush

About half of the sagebrush is in a large patch on the west side of the "U" with the rest in several patches that range from less than 1 acre to roughly 100 acres within the area of the Clear Fire. Nearly all the remaining sagebrush is low sage while the large sagebrush that was lost in the deeper soil areas was likely Wyoming big sagebrush (*A. tridentata* ssp *wyomingensis*) or Lahontan sagebrush (*Artemisia arbuscula* ssp. *longicaulis*), a stable hybrid of low sagebrush and Wyoming big sagebrush (Winward and McArthur 1995). Vegetation surveys conducted in 2007 (Horney 2008) near sage-grouse nesting areas in the Clear Lake Hills and the "U" indicate that Sandberg bluegrass (*Poa secunda*) and Idaho fescue (*Festuca idahoensis*) are by far the most common grasses in the area, accounting for 75% of all grasses and ungrazed plants in the survey area. Bluebunch wheatgrass (*Pseudoroegneria spicata*), western wheatgrass (*Achnatherum occidentale* ssp. *occidentale*), squirreltail (*Elymus elymoides*), intermediate wheatgrass (*Thinopyrum intermedium*), pubescent wheatgrass (*Thinopyrum intermedium* ssp. *barbulatum*), and crested wheatgrass (*Agropyron cristatum*) are other grasses in the area that could produce adequate residues for nest screening.

Upland shrubs consist primarily of low sage (*Artemisia arbuscula*) and Lahontan sagebrush, which is believed to be a hybrid of Wyoming big sagebrush, and low sagebrush as well as rabbitbrush (*Chrysothamnus* sp.). Grasses include bluebunch wheatgrass, Great-Basin wildrye (*Leymus cinereus*), Sandberg's bluegrass (*Poa sandbergii*), Idaho fescue (*Festuca idahoensis*), and bottlebrush squirreltail (*Elymus elymoides*).

Old Burns

In an effort to increase the forb coverage and availability for deer, pronghorn, and sage-grouse, prescribed fires were conducted on the refuge in the 1990s. In 1993, 100 acres of low sage on the west side of the "U" were burned to stimulate production of forbs and grasses. And in August 1995, an additional 800 acres of low sage on the northwest side of the "U" were burned. On July 3, 2001, a lightning strike ignited a wildfire (Clear Fire) on the "U" which burned across 3,800 acres on the refuge and 517 acres on the Modoc National Forest. Only the west side of the "U" and pockets of sagebrush within the perimeter of the fire were spared, likely because they were in rocky areas the fire could not reach. Mortality on low sagebrush plants was high because of the dry conditions and much of the fire was a backing fire with a longer dwell time on the plants rather than quickly burning over them. As a result of this fire, the sage-grouse lek on the north side of the "U" and the main lek on the southwest side were abandoned. However, since 2002 strutting has resumed on the west side of the "U" where the current main lek is located. Current vegetation in the non-sagebrush areas includes rocky areas, and perennial and annual grasses.

Aquatic Habitats

Clear Lake is turbid, or cloudy, with the turbidity caused by frequent mixing of small colloidal particles (Reclamation 2000). The lake lacks shoreline development and is shallow. It also has low biological productivity with small blue-green algae blooms during the summer months (Reclamation 2000). Shoreline areas lack emergent vegetation and submerged aquatic plants are limited to a few sites protected from the wind.

Fish and Wildlife

Waterfowl and Other Waterbirds

Clear Lake is one of the most important sites in the Klamath Basin for colonial waterbirds. Clear Lake hosts at least seven such species, including the largest of only two colonies of American white pelicans in California, and the main colony of Caspian terns in the Klamath Basin (Shuford et al. 2004). White pelicans are attracted to the refuge because of the availability of secure isolated nesting islands. Each island or series of islands is optimized for nesting under different lake levels. Average production on the refuge is 1,400 pelican fledglings annually.

The following narrative is from a letter to Russell Peterson, Oregon State Supervisor, Service, dated November 11, 1994, from Leopoldo Moreno, Ph.D. Candidate, U.C. Davis. Leopoldo conducted his doctoral research on white pelican ecology in the Klamath Basin.

> At Clear Lake, the location of white pelican colonies varies with the availability of nesting islands, which in turn are formed by water level fluctuations. The timing of island formation and their continued separation from major land masses is crucial for the success of ground-nesting waterbirds, especially during egg-laying and incubation when colonies are most vulnerable to predation by coyotes and raccoons. White pelicans have been recorded nesting at Clear Lake in four different locations depending on water conditions: Main Island, Rocky Islands, Bird Island, and Northwest Islands.

Estimated average production of ducks, coots, and geese at Clear Lake Refuge is shown in Table 5.21. Birds known or suspected to have recently nested on the refuge also include gray flycatcher, Say's phoebe, ash-throated phoebe, horned lark, scrub jay, pinyon jay, plain titmouse, rock wren, canyon wren, sage thrasher, Brewer's sparrow, and sage sparrow. Bird species that occur irregularly in the Klamath Basin are included in the species lists in Appendix H.

Table 5.21. Clear Lake Refuge Estimated Production of Ducks, Coots, and Geese, 2008 through 2014

Year	*Duck*	*Coot*	*Goose*
2008	146	0	74
2009	591	0	60
2010	1,716	14	69
2011	11	0	43
2012	356	0	126
2013	198	0	126
2014	110	339	154
Average	447	50	93

Mammals

The more common mammals on the refuge include mule deer, pronghorn, badger, coyote, and Beldings ground squirrel. Other mammals occurring on the refuge are discussed in Appendix H.

Amphibians and Reptiles

Appendix H provides a list of wildlife species occurring on the refuges in the Refuge Complex. Although many of the amphibians and reptiles included on the list for the Refuge Complex are expected to occur on Clear Lake Refuge, their presence is undocumented.

Fish

Fish occurring on the refuge include Pit-Klamath brook lamprey, multiple minnow species including speckled dace, multiple sunfishes, brown bullhead, Klamath largescale sucker, and two federally listed suckers discussed below. Appendix H includes more detailed information about the fish occurring on the refuge.

Federal- and State-Listed Species

Slender Orcutt Grass

Slender Orcutt grass, federally **listed as threatened, potentially occurs on Clear Lake Refuge given occurrences within the vicinity, but there are no known modern occurrences.**

Lost River and Shortnose Suckers

Clear Lake Refuge supports both Lost River and shortnose suckers **and their critical habitat**. Spawning by both species principally occurs in Willow Creek, a tributary to Clear Lake (Service 2002b). Data from 2004 to 2006 indicate that Lost River and shortnose suckers were relatively abundant in Clear Lake, although there was a lower frequency of large individuals present compared to data from the 1990s (Barry et al. 2007; Leeseberg et al. 2007; Service 2008). Such a change in length frequency suggests relatively good recruitment but low adult survivorship (Service 2002b).

Releases from Clear Lake typically occur from April through October for irrigated agricultural activities. From November through March, no water is released except for flood control purposes (Reclamation 2000). Fish passed through Clear Lake Dam are not able to reenter Clear Lake. In 1993, a large mesh barrier net was installed around the dam outlet works to restrict juvenile and adult suckers from leaving the lake during the irrigation season.

Clear Lake lacks emergent wetlands due to substantial fluctuations in water levels associated with Klamath Project operation and evaporation and seepage (Service 2008). It is estimated that with more lacustrine habitat and better access to spawning tributaries because of the Clear Lake Dam construction, sucker populations increased substantially (Service 2002b).

Gray Wolf

The endangered gray wolf potentially occurs on Clear Lake Refuge given occurrences within the vicinity, but there are no known modern occurrences.

Bald Eagle

Bald eagles are frequently sighted on the refuge, with a peak population of seven birds (Reclamation 2000).

American Peregrine Falcon

Peregrine falcons are occasionally sighted during the fall and spring waterbird migration.

Greater Sage-Grouse

The greater sage-grouse is the largest of the North American grouse. It is closely associated with sagebrush ecosystems of western North America. However, sagebrush habitat types have a tremendous amount of natural variation in vegetative composition, habitat fragmentation, topography, substrate, weather, and frequency of fire. Consequently, sage-grouse are adapted to a mosaic of sagebrush habitats throughout their range (Schroeder et al. 1999).

The greater sage-grouse historically occurred in at least 16 states and three Canadian provinces, but declines in its distribution have been documented throughout the twentieth century and it has been extirpated from British Columbia and five states (Schroeder et al. 1999). In California, the sage-grouse ranges from the Oregon border in northeastern California, along the east side of the Cascade Range and Sierra Nevada to northern Inyo County, with Lassen and Mono Counties having the most stable populations (Horney 2008). In California, sage-grouse are classified as a resident upland gamebird and a Species of Special Concern.

Clear Lake Refuge is located in the Devil's Garden sage-grouse population management unit, which covers roughly one quarter of Modoc County and a portion of eastern Siskiyou County. Although sage-grouse were found throughout most of the population management unit into the 1940s and 1950s, the population went into decline shortly thereafter (Horney 2008). The Devil's Garden/Clear Lake Sage-Grouse Working Group established the Clear Lake Active Management Area as the priority area for sage-grouse population and habitat management until the population is capable of expanding to other locations; primarily because the sole remaining active lek (strutting ground/mating area) and known nesting/rearing areas are located on Clear Lake Refuge and adjacent U.S. Forest Service lands**. Figure 5.9b summarizes the peak lek counts (number of males observed) from 1988 to 2015.**

Within the Clear Lake Refuge, the "U" (an approximately 5,000-acre peninsula that extends into the lake from the south) is used by sage-grouse year-around and is home to the last active lek in the Modoc Plateau (Horney 2008). Over the last quarter century, the sage-grouse's use of the 18 leks adjacent to the refuge has dropped to zero while attendance on the "U" lek has **declined** by 80% since 1992 (Horney 2008).

From late summer to fall, the lakeshore provides excellent forage for sage-grouse chicks as the lake recedes and forbs emerge on the newly exposed soil. Common shoreline forbs used by sage-grouse include clover, Lemmon's milk vetch, Modoc hawksbeard, Purshe's milk vetch, Great Basin lomatium, false buckwheat, and low everlasting. Upland shrubs consist primarily of low sage, Lahontan sagebrush, and rabbitbrush. Grasses include bluebunch wheatgrass, Great Basin wildrye, Sandberg's bluegrass, Idaho fescue, and bottlebrush squirreltail (Horney 2008).

Juniper encroachment, which has occurred since settlement of the refuge area, has been identified as one of the greatest risks to the continued existence of sage-grouse in the area. Juniper expansion has displaced sagebrush, which is vital as cover and food for grouse. From an aerial view, it becomes readily apparent that Clear Lake Refuge is like an island of sagebrush surrounded by a sea of junipers.

5.3.3 Cultural Resources

According to the *Klamath Basin National Wildlife Refuge Complex Cultural Resources Assessment* (Service 2011a), to date, recorded cultural resources known to be within the boundary of the Clear Lake Refuge consist of 11 recorded prehistoric sites (i.e., worked stone, stacked rocks, cleared areas, bedrock mortar) and one recorded historic site (i.e., rock enclosure). Although the area on and around the Clear Lake Refuge was used extensively by Native Americans, and there are an abundance of cultural resource sites, there have not yet been any nominated for inclusion onto the NRHP. A more detailed discussion of the cultural resources within the Refuge Complex is included in Appendix O.

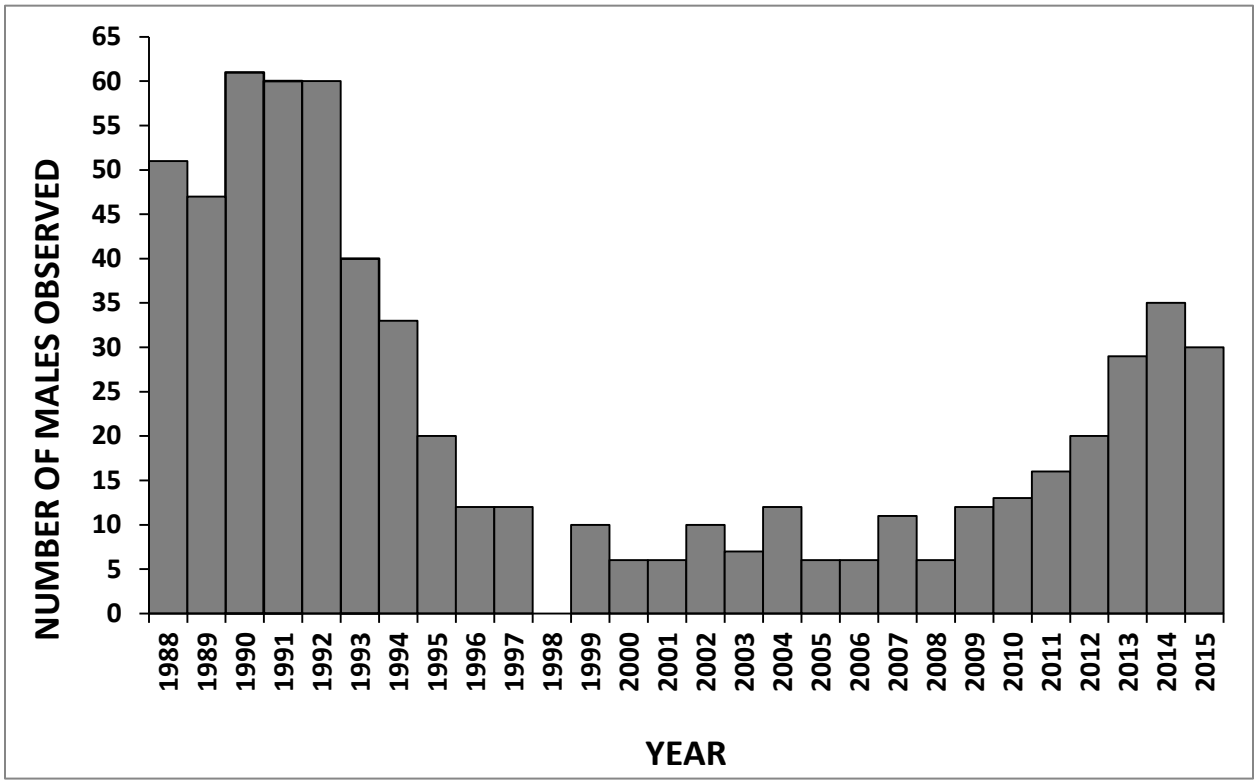


Figure 5.9b. Peak lek counts (# of males observed) at Clear Lake Refuge from 1988 to 2015. No lek counts were conducted in 1998.

5.3.4 Visitor Services

Clear Lake Refuge is currently open to waterfowl and antelope hunting. In addition, there are limited opportunities for wildlife observation and photography from U.S. Forest Service Road 136 which runs along the southern boundary of the refuge.

Hunting

Waterfowl

Sport hunting is permitted for waterfowl, including geese, ducks (including mergansers), American coots (*Fulica americana*) and common moorhens (*Gallinula chloropus*), and Wilson's snipe (*Gallinago gallinago*) on designated areas of Clear Lake Refuge. The hunt zone is located along the shoreline of Clear Lake (Figure 5.10). The exact acreage varies due to the ever-changing lake water level. The western shoreline is the only area open for waterfowl hunting, the remainder of the refuge is closed as sanctuary.

Clear Lake Refuge is remote, and access is limited and can be difficult (especially in wet or cold weather). Additionally, the hunt area is open with very little cover, water levels in the reservoir can be very low in the fall/winter, use of boats is prohibited, and hunting success is only fair. As a result, the area is not heavily used by waterfowl hunters. The hunt area is accessed by walking in from the refuge boundary. Hunters are encouraged to use temporary blinds. Compared with Lower Klamath and Tule Lake Refuges, the number of waterfowl hunters visiting Clear Lake Refuge is very low (approximately 50–200 annually in recent years) according to the multi-year visitor use data (Service 2003a). Due to the remoteness of the hunt area and the relatively low numbers of hunters, waterfowl hunting conditions are generally uncrowded.

This use also includes operation of an annual youth waterfowl hunt. This special hunt is scheduled by the CDFW and usually occurs in September (14 days prior to the opening of the northeast zone general waterfowl hunting season) and on selected dates during the regular season. Youths age 15 or younger can participate in this youth hunt provided they are accompanied by an adult, age 18 or over. Adults cannot hunt during this season. A special ladies' hunt is also held on the refuge in conjunction with the first youth hunt during the regular season. Ladies would be allowed to hunt from 1:00 p.m. until the end of the state's shooting time.

Seasons, hours, bag limits, and other rules for waterfowl hunting on the refuge are the same as those published annually by CDFW for hunting of migratory game birds (CDFW 2014). Waterfowl hunting is allowed on the refuge 7 days per week within the state-regulated season (generally October through January).

Pronghorn Antelope

Pronghorn antelope hunting is by permit only and on a very limited basis. The CDFW conducts a special drawing from successful tag holders of the Clear Lake Zone (zone 2). A maximum of six permits are allowed each year. This hunt is limited to the "U" Unit of the refuge on weekends and holidays beginning on the first Saturday following the third Wednesday in August. The "U" is 6,320 acres and is approximately 19% of the 33,500 total refuge acres. Access to the hunt unit is walk-in only through the designated gate at the south end of the refuge along County Road 136 (also known as Clear Lake Road) (see Figure 5.10).

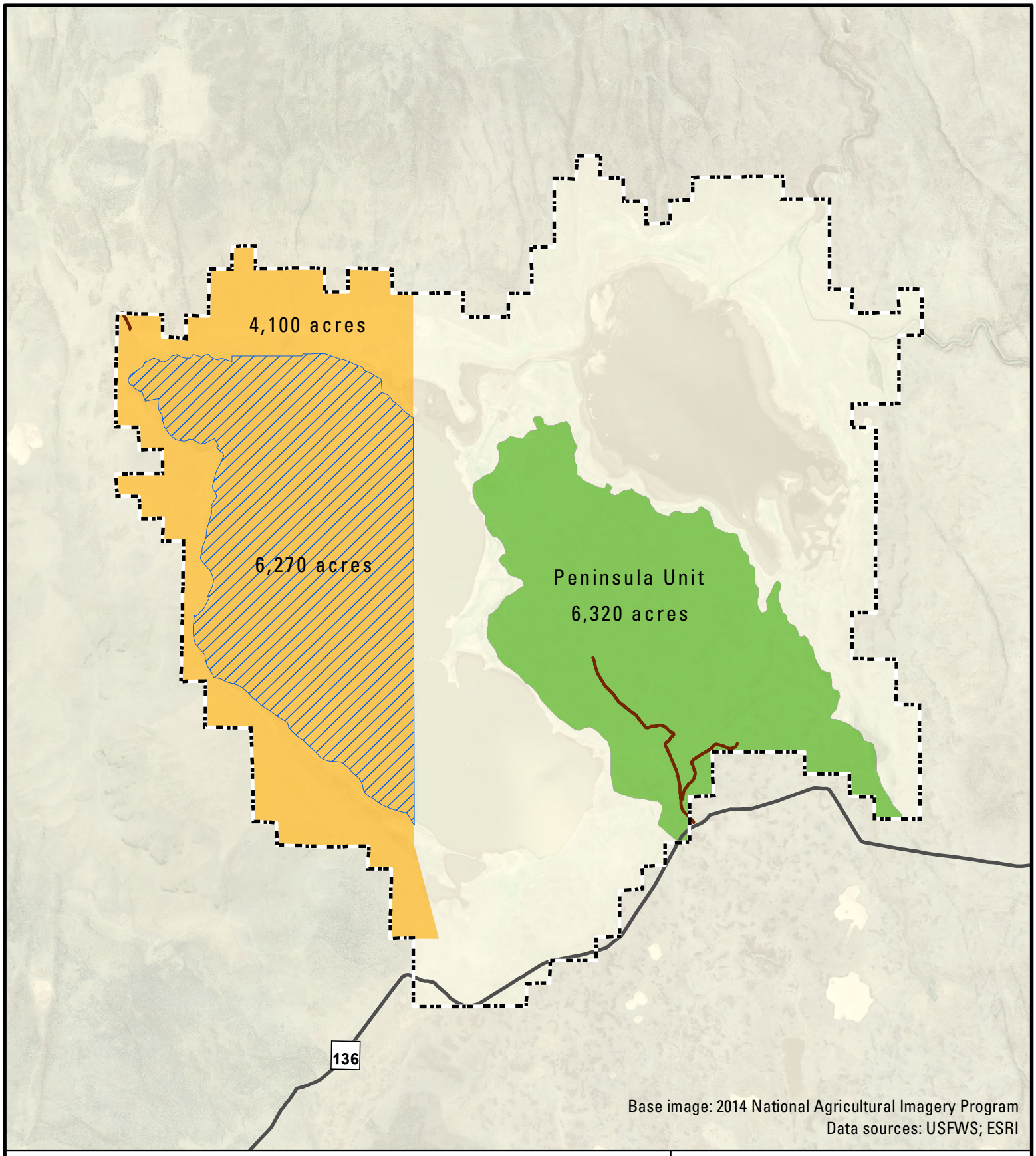


Figure 5.10. Visitor Services - Clear Lake Refuge

Wildlife Observation and Photography

Wildlife viewing is only possible from U.S. Forest Service Road 136 where it passes along the southern edge of the refuge.

5.3.5 Management and Monitoring Practices

Habitat/Water Management

Water Management

Clear Lake water levels are presently regulated by Reclamation for flood control and irrigation with minimum lake level at the start of the winter period from October to February at 4,520.6 feet. This elevation is anticipated to provide adequate water depths for protection against winter-kill of suckers (Service 2008).

Habitat Management

In an effort to increase the amount of forage available for deer, pronghorn, and sage-grouse, some prescribed fires were conducted on the refuge in the 1990s. In 1993, a 100-acre prescribed fire on the west side of the "U" was lit in low sage to stimulate production of forbs and grasses. In August 1995 an additional 800 acres of low sage on the northwest side of the "U" were burned. In July 2001, a lightning-caused wildfire burned over approximately 80% of the "U."

Invasive Species Management

Small amounts of the invasive annual grasses medusahead and cheatgrass are found primarily on the southwest corner and south side, respectively, of the refuge. Western juniper has spread into the refuge primarily on the north side and to a lesser extent the south side. The spread of western juniper is a threat to the sage-grouse population. **Bell (2011) notes that the western juniper present in the study area includes junipers interspersed within sagebrush, which is described in Horney (2008) as juniper encroachment that is negatively affecting greater sage-grouse habitat. Removing juniper encroachment is highly effective at functionally restoring sage-grouse landscapes (Baruch-Murdo et al. 2013; Davies et al. 2011). Baruch-Murdo et al. (2013) conducted modeling of lek activity as a function of western juniper presence with the results showing that lek activity is reduced where small trees were dispersed, larger trees clustered, or canopy cover is over 4%, whether the areas had active encroachment or more established stands. Lek use by males is linked to female nest settlement (Bradbury et al. 1988).**

In 2006, the Service obtained grant funding to remove encroaching juniper trees and in the fall over 1,400 acres of the refuge were treated. The work was done by a contract crew with chainsaws and the trees were bucked up and left in place to provide wildlife cover. Most of the junipers cut were small to medium-sized trees that were encroaching into low sage areas. Large junipers located in rocky areas (where they have persisted over time, safe from fire) that contained excavated cavities or had other signs of wildlife use were left standing.

In 2010, Clear Lake Refuge managers and University of California researchers formed a collaborative project to research methods for improving sage-grouse habitat on the Clear Lake Refuge. Funding was secured for 2 years, and an experiment was established at Clear Lake

Refuge starting on October 1, 2010, and completed on April 1, 2015. The experiment examined the influence of herbicides used in combination with or without reseeding for restoration of degraded sagebrush plant communities. Three herbicide treatments were evaluated: 2010 fall-applied imazapic, 2010 fall-applied rimsulfuron, and 2011 spring-applied glyphosate. Herbicide rates and application timings were designed to maximize annual grass control while minimizing non-target plant injury. To summarize, 2011 and 2012 results suggest imazapic and rimsulfuron effectively control medusahead and cheatgrass the year of treatment. Annual grass cover in imazapic- and rimsulfuron-treated plots was less than the untreated control the year after treatment, but medusahead had started to re-infest most plots. Medusahead control more than 2 years after treatment with these two herbicides is questionable. Glyphosate reduced annual grass cover by 60% to 70% the year of application, but annual grass populations rebounded to untreated levels 1 year after glyphosate treatment. The most dramatic observed change in this project was the reduction in litter. Litter from medusahead has a tendency to increase the competiveness of the plant and reduce the ability of other seedlings to become established (University of California 2015).

In 2012, the "Clearlake Medusahead Project" began to evaluate livestock grazing as a tool to manage the invasive plant. Forty cow-calf heifer pairs and one bull were grazed in an approximately 80-acre pasture for 24 days. In 2013, the changes in cover composition showed the following. Annual grasses were 23% less in grazed areas compared to ungrazed (27% vs. 52% respectively). Perennial grasses were 12% in the ungrazed exclosure and 22% in the grazed area. Although the increase is mostly attributed to an increase in *Poa secunda*, forb composition was 7% greater in grazed areas compared to ungrazed (21% versus 14% respectively). Especially evident was the amount of big headed clover and desert parsley present. Additionally, areas of bare ground were similar between grazed and ungrazed (15% and 12%). The "Final Research Update" for the project concluded that such intensive grazing would be difficult to complete on a large scale (greater than 160 acres) with cattle. However, it seems to be effective on a small patch as a prescriptive grazing technique. It may be more successful on a larger scale with sheep, as they can be concentrated and moved more easily (University of California, unpublished. circa 2014). Recently grazed areas on the Clear Lake Refuge are illustrated in Figure 5.11.

Fire Management

Since wildfires can quickly consume vital habitat, fire suppression is mandated for the refuge.

Fish and Wildlife Management

Lost River and Shortnose Suckers

As described above, the minimum lake elevation for Clear Lake is dictated by the 2002 BiOp. This level was determined to be sufficient for the Lost River and shortnose suckers. In addition, Clear Lake dam was screened in 2003 to prevent the entrainment of juvenile and adult suckers.

Greater Sage-Grouse

In order to add genetic diversity and augment the extant population of greater sage-grouse on the Clear Lake Refuge until the time that it can be sustained by natural reproduction, sage-grouse have been translocated to the refuge. Translocations began in spring of 2005 with birds captured at Hart Mountain Refuge. Since then, sage-grouse have been translocated from Sheldon Refuge

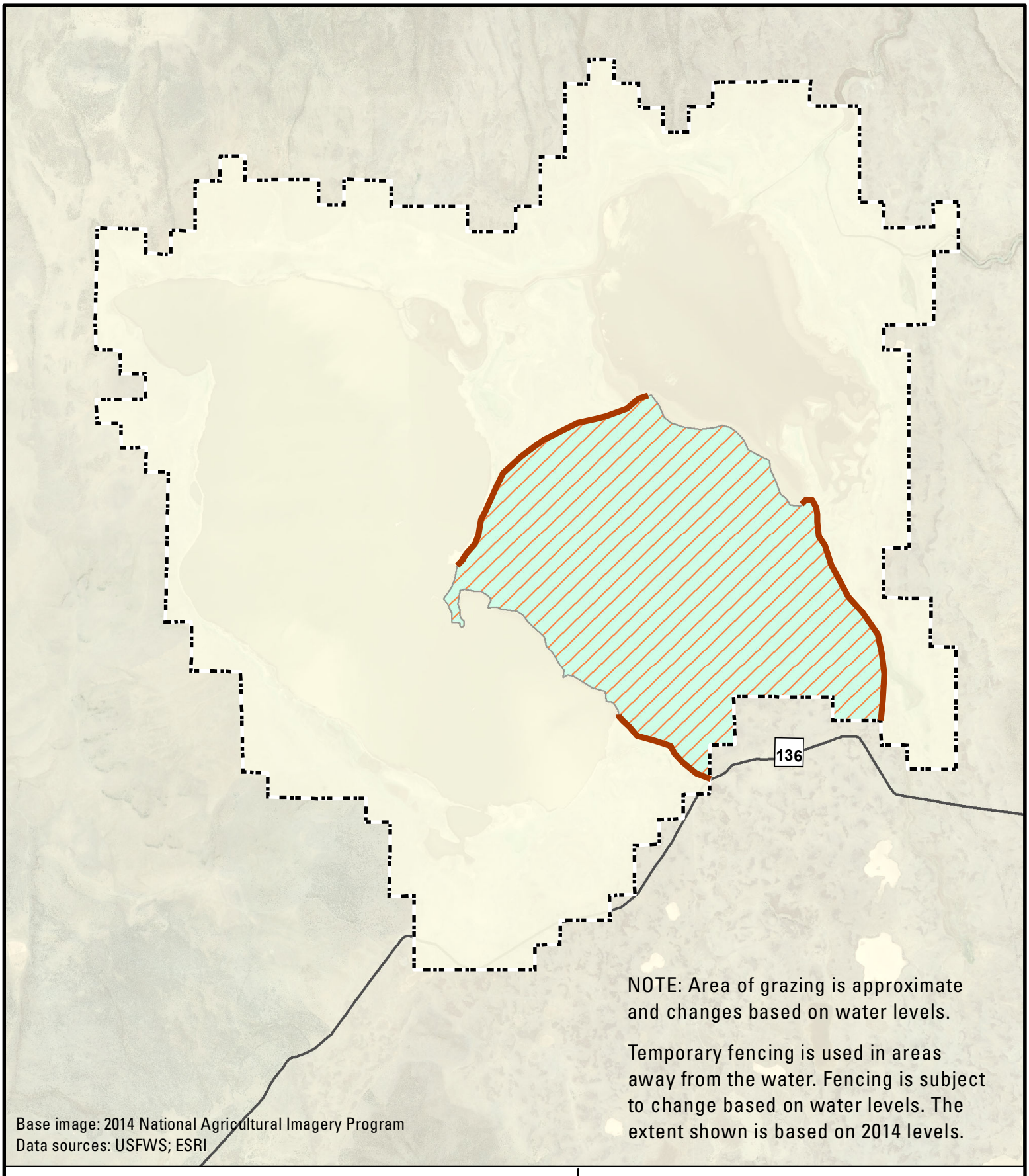


Figure 5.11. Grazing Area - Clear Lake Refuge

and BLM land in northern Nevada. Translocated grouse currently occupy the Clear Lake Refuge and parts of the Modoc National Forest. From 2005 to 2008, annual survival of first year translocated birds has ranged from 0.31 to 0.67 and is comparable with survival rates found in other studies (Beckstrand 2009). The Devil's Garden/Clear Lake Sage-Grouse Working Group proposes to translocate and monitor 40 birds in 2009 with up to 30 birds translocated for each of the next 5 years (Beckstrand 2009).

Since 2006, over 86% of juniper-encroached habitats on Clear Lake Refuge have been cleared (see below) (Beckstrand 2009). Because junipers on the refuge were sparsely distributed, sagebrush canopy cover and the herbaceous understory are in good condition resulting in "instant habitat" for the sage-grouse (Beckstrand 2009).

Wildlife Monitoring

Table 5.22 summarizes the period of record, frequency, and timing of current and historic surveys on Clear Lake Refuge. These data in conjunction with the biologist's judgment are used in determining whether wildlife use is meeting objectives for a particular habitat.

Table 5.22. Clear Lake Refuge Period of Record, Frequency, and Timing of Current and Historic Surveys

Survey Name	*Start Year*	*End Year*	*Frequency of Survey*	*Survey Timing*	*Status*
Breeding Canada Goose Pairs	1950	Indefinite	Recurring - every year	Mid-March	Current
Breeding Duck Pairs Survey	1950	Indefinite	Recurring - every year	Mid-May	Current
Caspian Tern Survey	1997	Indefinite	Recurring - every year	Mid-June	Current
Colonial Waterbird Surveys	1970	Indefinite	Recurring - every year	Methods and timing depend on the species	Current
Greater Sage-grouse Telemetry	2000	Indefinite	Recurring - every year	Year-round	Current
Mid-Winter Waterfowl Survey	1960	Indefinite	Recurring - every year	Early January	Current
Periodic Waterfowl Surveys	1950	Indefinite	Recurring - every year	September–April	Current
Sage-grouse Lek Survey	1950	Indefinite	Recurring - every year	April 1–June 1	Current
Sage-Steppe Vegetation Survey	2010	Indefinite	Recurring - every year	Mid-June	Current

5.3.6 Environmental Justice

On February 11, 1994, the President issued Executive Order (EO) 12898 ("Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations") requiring that all federal agencies achieve environmental justice by "identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations." Environmental justice is defined as the "fair treatment for peoples of all races, cultures, and incomes, regarding the development of environmental laws, regulations, and policies."

5.4 Tule Lake National Wildlife Refuge

Tule Lake Refuge is located in extreme northern California in Modoc and Siskiyou Counties, approximately 6 miles west of the town of Tulelake, California. The refuge was established by President Calvin Coolidge on October 4, 1928, via EO 4975, and was amended by two subsequent EOs: EO 5945 dated November 4, 1928, and EO 7341 dated April 10, 1936. The EO language

states in part that the lands are to be managed "... as a Refuge and breeding ground for wild birds and animals."

5.4.1 Physical Environment

Geographic Setting

Tule Lake Refuge is located at an elevation of approximately 4,000 feet, and is 39,116 acres in area, consisting mostly of lands "reclaimed" from under the waters of historic Tule Lake (see Figure 1.3). The southern boundary of the refuge is adjacent to the Lava Beds National Monument (see Figure 1.5).

Tule Lake Refuge consists of two open water sumps (reservoirs totaling 13,000 acres) surrounded by croplands. A portion (currently, about 14,800 acres) of the surrounding area is farmed by Reclamation lessees. Refuge permittees farm another 2,300 acres of cereal grain. This crop, together with the waste grain and potatoes from the lease program, is a major food source for migrating and wintering geese and other field-feeding waterfowl. Irrigation water is managed by the TID under a contract with Reclamation.

Topography within lake bottom agricultural and wetland habitats is flat or nearly so with surrounding lands containing sparsely timbered hills, uplifts, and cinder cones. A small portion of the refuge along the west boundary includes the steep hillsides and rock outcrops of Sheepy Ridge.

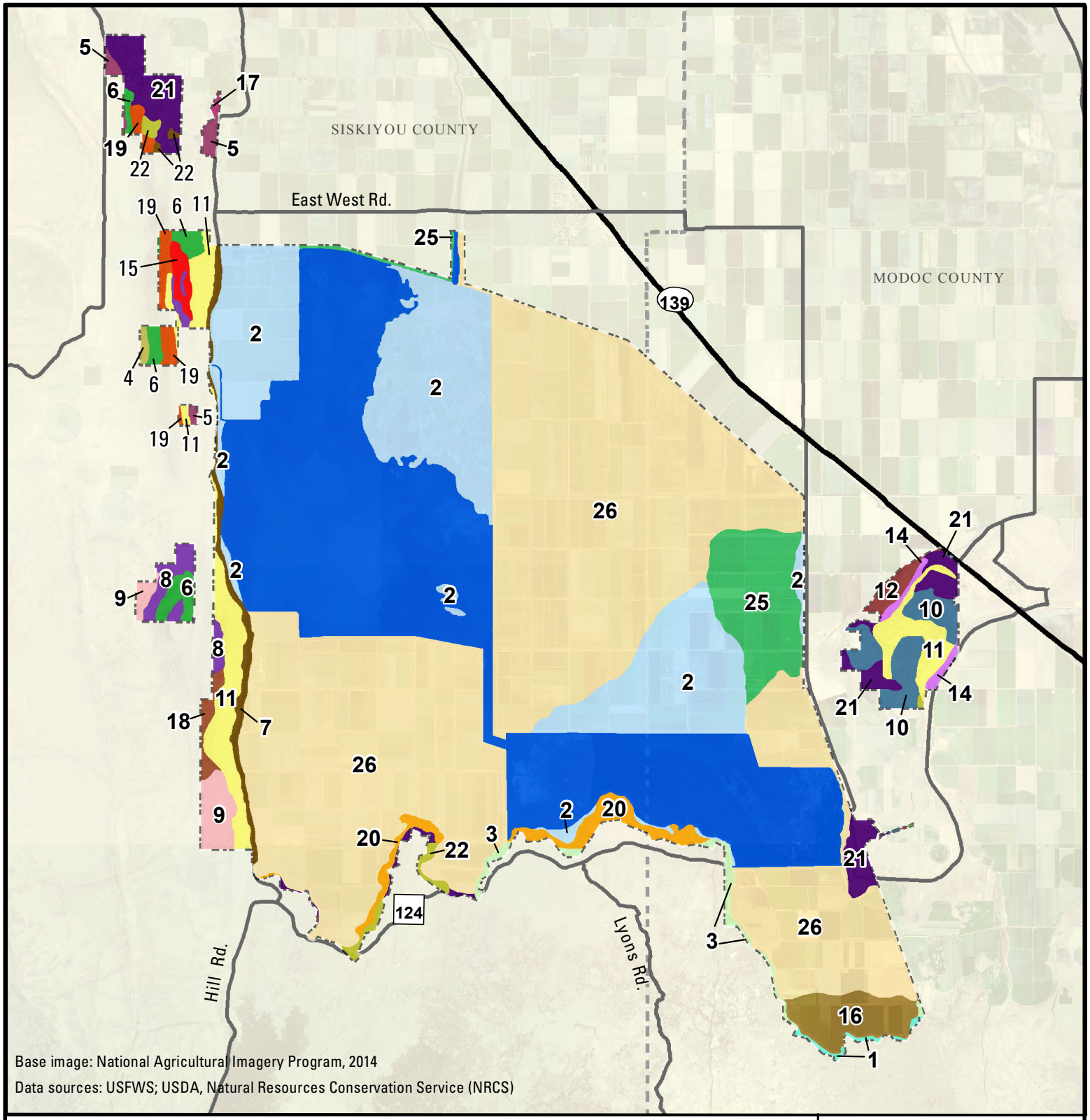
Geology

Tule Lake, a sub-basin at the southeast end of the Klamath Basin, lies between the southern Cascade Range and the Great Basin near the western margin of the Modoc Plateau (MacDonald 1966). The area is dominated by basalt flows and continental sedimentary rocks (Bradbury 1992). Graben development, damming by lava flows, and a favorable hydrologic balance allowed large lakes to persist in the Klamath Basin south and north of the Oregon-California border during the late Cenozoic (Bradbury 1992).

Soils

Soils on the Tule Lake Refuge are some of the most productive agricultural soils in the basin because they are deep and have 5% to 15% organic matter. These soils are now drained and irrigated with a series of interconnected canals and ditches. These are deep muck soils that were formed when the land was covered by water. There are 26 soil series or soil complexes on the refuge (Figure 5.12). Of these, three soil series comprise 60% of the soil on the refuge. Water is present on 25% of the refuge. The remaining 23 soil series comprise 15% of the refuge. The properties of the primary soil series that underlie the refuge are as follows.

Capjac silt loam: The Capjac series consists of very deep, poorly drained soils that formed in lacustrine deposits influenced by high amounts of volcanic ash and diatoms. Capjac soils occur on lake basins and have slopes of 0% to 1%. These soils are poorly drained with medium surface runoff and moderate permeability. These soils have a water table at depths of 1.5 to 3.0 feet from January to December. Capjac soils are used for irrigated cropland, wildlife habitat, and rangeland.



Approved acquisition boundary

Water

soil type

- 1-Bakeoven family-Lava flow-Lithic Xerorthents, mesic association
- 2-Capjac silt loam
- 3-Capona-Rock outcrop complex
- 4-Capona cobbly loam
- 5-Dehill fine sandy loam
- 6-Demox-Rubbleland complex
- 7-Demox stony sandy loam
- 8-Dunnlake-Bucklake complex
- 9-Dunnlake-Rangee complex
- 10-Fordney loamy fine sand
- 11-Karoc-Rock outcrop complex
- 12-Laki fine sandy loam
- 13-Leavers sandy loam, drained
- 14-Lequieu very stony loam
- 15-Madeline-Capona complex
- 16-Pit silty clay
- 17-Rojo sandy loam
- 18-Searles-Orhood complex
- 19-Searles-Rubbleland complex
- 20-Searles variant very stony loam
- 21-Stukel-Capona complex
- 22-Stukel sandy loam
- 23-Truax-Searles
- 24-Truax fine sandy loam
- 25-Tulana silt loam
- 26-Tulebasin mucky silty clay loam

Figure 5.12. Soils - Tule Lake Refuge

0 1 2 miles

Cattails and bulrush are the primary plants found on soils that have not been reclaimed for agriculture. The Capjac series is 14% of the refuge. Tulebasin mucky silty clay loam: The Tulebasin series consists of very deep, very poorly drained soils that formed in lacustrine deposits derived from diatoms and volcanic ash. These soils are in lake basins and have slopes of 0% to 1%. Runoff is very slow and permeability is slow on Tulebasin soils. Tulebasin soils are used as cropland and for hay and pasture. The Tulebasin series is 43% of the refuge.

Tulana: The Tulana series consists of very deep, poorly drained soils that formed in lacustrine sediments high in diatoms and amorphous material. Tulana soils are on lake bottoms and have slopes of 0% to 1%. Soils in their natural condition have an aquic soil moisture regime. In aquic soil moisture regimes soil is saturated with water long enough that dissolved oxygen is virtually absent. Soils in this series are ponded or have very slow runoff with moderately slow permeability. These soils are used for irrigated pasture and small grains and for wildlife habitat. Vegetation on undrained areas consists mainly of cattails and bulrushes. The Tulana series is 3% of the refuge.

The potential for water-based erosion on these soil types is low because they each occur on slopes of 0% to 1%. Wind-based erosion at Tule Lake is moderate (Figure 5.13). The soil series in the agricultural areas have an erodability index of 2, with the exception of the Tulana silt loam which has an erodability index of 3. Freshwater emergent marsh has a wind erodability scale of 0.

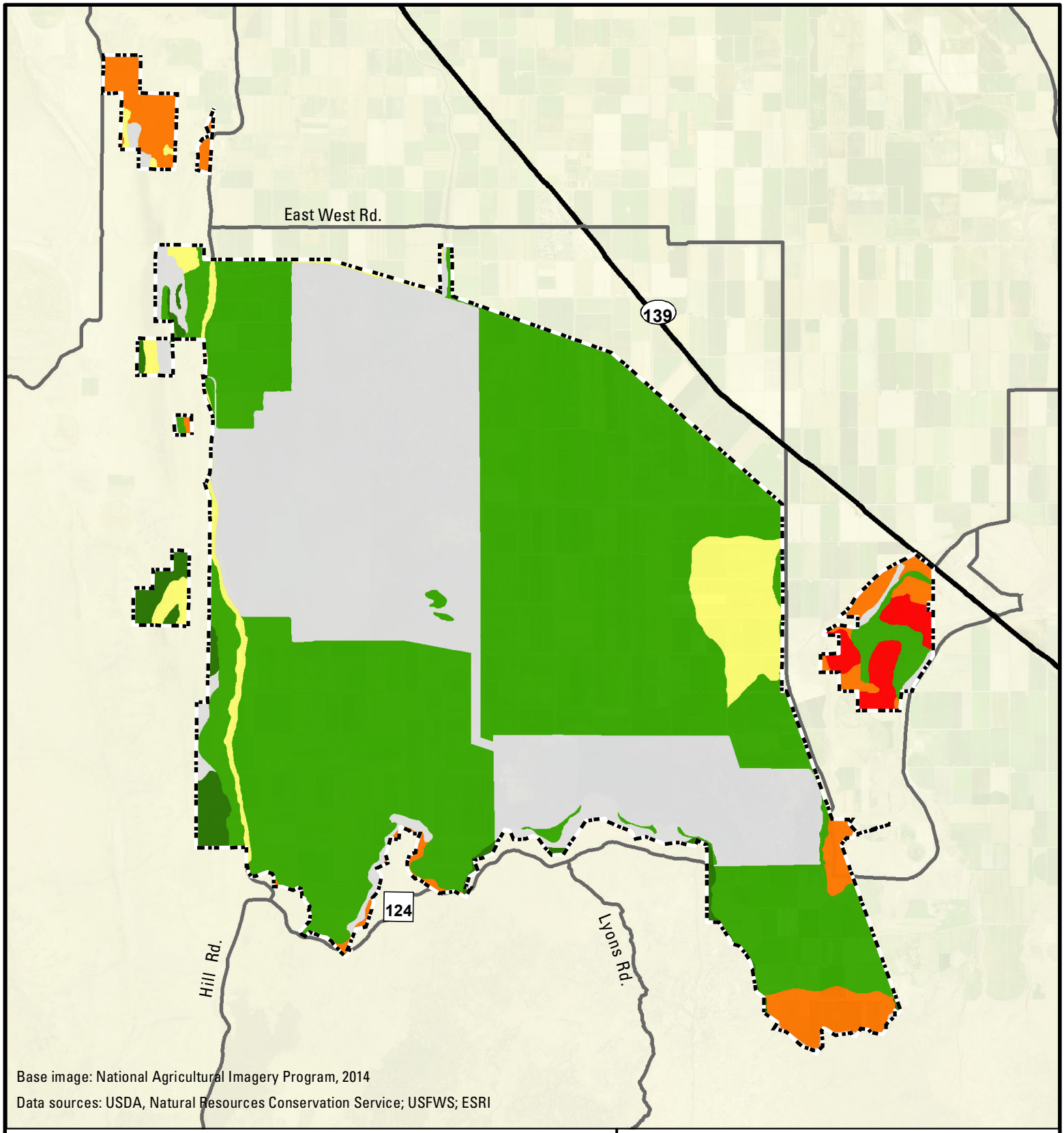
On the Peninsula Unit the wind-based erodability is higher (ranging from 2 to 5) because the soils are more sandy and loamy.

Hydrology

Tule Lake Refuge receives primarily return flows from private agricultural lands north and east of the refuge. The refuge is composed of Sumps 1A and 1B which act as collecting basins for agricultural return flows during the spring/summer irrigation season and runoff during winter and spring precipitation events. Sumps 1A and 1B are surrounded by agricultural lands (Sumps 2 and 3) which are leased to local farmers under provisions within the Kuchel Act of 1964. Excess water in Sumps 1A and 1B is removed via a tunnel (D Plant) through Sheepy Ridge to Lower Klamath Refuge.

Farm lands in Sump 2 (5,657 acres) are served by the Q and R Canals. Both canals divert water from a single source: Tule Lake. The average annual inflow to Sump 2 is 22,364 acre-feet and the average annual outflow is 15,844 acre-feet. Almost all of the inflow and outflow (94%) occurs during the April through October irrigation season. Average annual crop evapotranspiration is 11,793 acre-feet in the April through October irrigation season.

Farm lands in Sump 3 (11,275 acres) are served by the North N Canal, which serves both public and private lands. The total supply to the N Canal averages 83,330 acre-feet annually and 74,567 acre-feet in April through October. Water not used to irrigate crops or that is lost to evapotranspiration is returned to Sumps 1A and 1B. Average annual crop evapotranspiration in Sump 3 averages 20,490 acre-feet during the April through October irrigation season.



Approved acquisition boundary

Soil Erodibility (scaled, low to high)	% of total area
0	33.6
1	1.8
2	54.2
3	4.7
4	4.4
5	1.2
6	0

Figure 5.13. Soil Erodibility from Wind - Tule Lake Refuge

0 1 2 3 miles

Tule Lake Sumps 1A and 1B (13,021 acres) receive water from the Lost River via Anderson Rose Dam spills; N Canal spills; return flow pumps adjacent to the lake; and precipitation. Sources of inflow to Tule Lake vary by season. Return flow pumps are the largest source of water to Tule Lake, averaging 81,248 acre-feet annually, but most of this inflow (73,704 acre-feet) arrives during the April through October irrigation season. However, in recent years, return flows have declined due to reduced project water supply for upstream agricultural lands and increased canal losses due to groundwater pumping (Pischel and Gannet 2015). Most of the Anderson Rose Dam inflow (24,556 acre-feet) is outside of the irrigation season. N Canal spills (18,241 acre-feet) are almost entirely during the irrigation season. Precipitation is a relatively small component of inflow (13,095 acre-feet annually). D Plant pumping is the largest source of outflow from the lake (84,186 acre-feet annually and 51,321 acre-feet April–October). Evaporation is the second largest source of outflow at 50,055 acre-feet annually. Irrigation diversions from the lake total 32,254 acre-feet, almost all of which occur during April through October. Most of the irrigation diversions go to Sump 2, followed by Sump 3. The difference between inflows and outflows in Tule Lake is considerable. Outflows have exceeded inflows an average of 30,331 acre-feet annually and 21,151 acre-feet in April through October for the 10-year period of record. The difference may be due to measurement error or groundwater inflow.

Water Quality

Tule Lake sumps are highly eutrophic because of high concentrations of nutrients, and resultant elevated aquatic plant productivity causes large fluxes in dissolved oxygen, pH, and ammonia (Service 2007b). Tule Lake water quality is affected by its various sources of inflow, as well as conditions in the sumps. During the irrigation season, the primary source of water for the sumps is Upper Klamath Lake, via the Lost River Diversion Channel and A Canal.

Tule Lake experiences poor water quality during summer months, characterized by high water temperature and pH, low dissolved oxygen levels, elevated un-ionized ammonia and nutrient concentration, and intensive filamentous green algae growth (Reclamation 2007). During the winter, most inflow to Tule Lake is from localized runoff below Wilson Reservoir (Service 2002b). Water quality can vary seasonally and diurnally, especially in summer. Due to the shallowness of the lake and high biomass of aquatic macrophytes and filamentous green algae during summer, dissolved oxygen and pH levels fluctuate widely. Water quality conditions during the winter are relatively good, except during prolonged periods of ice-cover when dissolved oxygen levels decline. A small adult sucker die-off occurred during the winter of 1992–1993 during an extended period of ice-cover and low dissolved oxygen levels (Reclamation unpublished data).

Oregon and California TMDL assessments have been completed for both the Lost and Klamath Rivers, and Upper Klamath Lake. Specific impariments and load allocations have been identified for Tule Lake. The California and Oregon Lost River TMDLs address dissolved oxygen, ammonia, pH, and chlorophyll-*a*. Specific criteria were developed for dissolved oxygen and DIN) that would also address pH and chlorophyll-*a*. TMDL load allocations for dissolved oxygen were represented by CBOD and DIN. Allocations were defined as a 50% reduction in CBOD and DIN for overall non-point load allocations, including all irrigation drainage loads throughout the study area, which include lands within the Tule Lake Refuge. Temperature was not identified in the California TMDL, and in Oregon temperature TMDLs are undergoing review.

Mayer (2005) completed a review of general nutrient-related water quality conditions on the Lower Klamath Refuge. Mayer assessed three specific types of wetlands that exist on the refuge: seasonal, farmed, and permanent wetlands (only the permanent wetland was studied in the Tule Lake Refuge). The findings at both Tule Lake and Lower Klamath Refuges for all wetland types are assumed to apply to Tule Lake Refuge. For all sites, inorganic nitrogen and inorganic phosphorus, and particulate nitrogen and particulate phosphorus loads were reduced in all types of wetlands with overall mass reductions ranging from approximately 15% to over 80% due to processing, sedimentation, and uptake. One exception was inorganic phosphorus in the seasonal wetland during the summer period, which was a net source (Mayer 2005). The summer period inorganic phosphorus increase in loads exported from the system was presumed to be due to operations including drainage from seasonal wetlands and farmed units. Ongoing operations of these managed units can have water quality impacts on the response of each wetland depending on to residence time, vegetation management, land use activities, wetting and drying cycles, and other factors. These findings are typical for a range of wetlands that typically reduce nutrients through uptake, processing, and settling (Crites and Tchobanoglous 2005; Kadlec and Knight 2004).

Danosky and Kaffka (2002) found that wetlands and farming practices in the southern portion of the Klamath Project result in the net removal of nutrients from the waters diverted for irrigation on a yearly basis. Although nutrient loads have been found to generally decrease over refuges and farmed units on an annual basis (Danosky and Kaffka 2002; Mayer 2005) nutrient concentrations generally increase from inputs to discharge waters. Mayer (2005) found nitrogen and phosphorus concentrations to generally increase from wetland inflows to wetland discharge. Danosky and Kaffka (2002) found total phosphorus and total nitrogen concentrations to increase at each step over the pathway from input waters to TID at the J Canal, to water leaving the Tule Lake sumps at the D Plant, to water leaving Lower Klamath Refuge at Klamath Straits Drain at Stateline, and to water at the end of Klamath Straits Drain prior to discharge into the Klamath River.

Reclamation maintains a long-term water quality monitoring program (1991–2013) in the project area, and these data were used to assess inflow (Lost River at Anderson Rose Dam) and outflow (D Plant) conditions. Examining upstream and downstream conditions, total nitrogen more than doubles through the refuge, and total phosphours has little change over the long term. Inorganic nitrogen and inorganic phosphorus undergo long-term reductions through the refuges on the order of 25% and 50%, respectively. Tule Lake sumps, as noted above, experiences seasonal primary production, which is presumed to lead to increased total nutrient loads, as well as decreased inorganic forms.

Dissolved oxygen processes have not been explicitly assessed on the refuge, and CBOD data are unavailable to determine demands at this time. Using the 1991 through 2013 Reclamation data set to examine dissolved oxygen at inflow (Lost River at Anderson Rose Dam) and outflow (D Plant) indicates that for the long term, average dissolved oxygen conditions are similar upstream and downstream of the refuge. Maximum and minimum values range from over 17 mg/L to less than 2 mg/L, respectively, at both sites indicating conditions where the basin plan objective of 5 mg/L is not met, and that a significant impact exists under current conditions.

Because the TMDL implmentaton planning process is ongoing, the impact of the refuges on reduction in nutrients and on dissolved oxygen concentrations on final TMDL implementation actions has not been defined at this time. The TMDL includes specific information on process and planning, as well as possible BMPs to be considered in a collaborative stakeholder process.

Environmental Contaminants

Studies done in the early 1990s indicated a variety of pesticides were present in waters and sediments around Tule Lake sumps; however, the measured levels were all below those known to be acutely toxic to aquatic life (Cameron 2008; Dileanis et al. 1996). More recent monitoring for pesticides in Tule Lake (Cameron 2008; **unpublished data 2011) suggests that only a few pesticides may be present and at very low levels.**

In addition, un-ionized ammonia concentrations in water sources, drains, and receiving waters around the Tule Lake sumps have been at potentially toxic levels (Dileanis et al. 1996). Nevertheless, the frequent low dissolved oxygen levels in the sumps may pose the greatest threat to aquatic life, including fish (Service 2007b).

Fire History

From 1936 to 2005, there were 58 wildfires on Tule Lake Refuge. The agricultural uses on the refuge have led to a high incidence of wildfire, often the result of escaped prescribed fires or vegetation debris burns. Until recently, lessees were permitted to burn their fields. Some of these burns escaped the intended fields, explaining a large percentage of wildfire activity on the refuge. These types of wildfires have varied from only a few acres to over 3,000 acres.

The high mountain desert climate combined with cured grasses and gusty winds have also been factors in a number of Tule Lake Refuge wildfires. The refuge is bordered to its west by Sheepy Ridge, a remnant of the once highly volcanically active basin. The ridge is covered in readily combustible fuels and has caught fire numerous times over the decades.

5.4.2 Biological Resources

Vegetation and Habitat Resources

Tule Lake Refuge habitats are composed of approximately 13,000 acres of permanent wetlands, and 17,000 acres of croplands (Figure 5.14). Within cropland areas, up to 2,700 acres of wetlands are managed within a managed crop rotation system (termed “Walking Wetlands”). The remainder of the lands is composed of sagebrush uplands and rocky outcrops.

Croplands

Two kinds of croplands exist on Tule Lake Refuge: agriculture leases where crops such as small grains, potatoes, alfalfa, and onions are grown; and cooperative farmlands, which include potatoes and small grains as well as a walking wetlands component. Farmers in cooperative farming areas leave from 25% to 33% of the grain area unharvested for waterfowl consumption. More detailed descriptions of the lease land and cooperatively farmed units are included in the Management and Monitoring Practices, section 5.4.5.

Uplands

Tule Lake Refuge contains approximately 5,400 acres of upland plant communities, including juniper woodland, sagebrush shrubland, and grassland. The peninsula area (southeast corner of the refuge) includes the largest block of upland habitat. It is composed primarily of cheatgrass, Idaho fescue, basin wildrye, rabbitbrush, and sagebrush.

Wetlands

Today, the Tule Lake Refuge includes 13,240 acres of wetlands called Tule Lake Sumps 1A and 1B. In addition, a network of drainage ditches provides aquatic habitat. Water from these ditches is pumped into the sumps. Sump habitats are a combination of permanently flooded wetland and open water with submersed vegetation. Vegetative types consist primarily of emergent plants, such as hardstem bullrush and cattail, and submersed plants, such as sago pondweed. Plant and animal diversity on Tule Lake Sumps 1A and 1B is lower than that on Lower Klamath Refuge. This is due to degradation from siltation, stabilized water levels, and poor water quality (Mauser 1994b).

Fish and Wildlife

Waterfowl and Other Waterbirds

During the 1950s and 1960s, the open water and agricultural lands of this refuge supported one of North America's greatest concentrations of autumn migrant waterfowl (Butcher 1963) and in the 1970s, it was considered the most important waterfowl refuge in the nation (Laycock 1973). However, the water quality and other biological resources on the refuge have declined since then.

Despite the loss of much of its productivity, Tule Lake Refuge remains one of the most important waterfowl migrational staging areas in the Klamath Basin. Important species include white geese (snow and Ross's) and cackling, Canada, and Pacific white-fronted geese.

The refuge also supports a substantial population of breeding waterfowl (Table 5.23). During late summer, Tule Lake Refuge is a focal point for molting waterfowl. Between 50,000 and 100,000 waterfowl from throughout the Intermountain West and California spend the late summer flightless period (July–September) in the security of emergent marshes at the refuge.

In addition to waterfowl, the sumps support large populations of fish-eating birds during the spring and summer months. Sumps 1A and 1B represent the primary feeding locations for the large pelican breeding colonies at Clear Lake Refuge.

Leased agricultural lands on Tule Lake Refuge are used by spring and fall migratory waterfowl. This particular habitat provides a high-energy carbohydrate food source for the birds during the southward migration to wintering areas in California and Mexico, and on the northern migration to breeding areas in the United States, Canada, and Russia. The Walking Wetlands Program diversifies waterfowl and other wildlife use of the leased lands by providing short-term wetland habitats. This is especially true for breeding and migratory shorebirds as well as a host of other wetland-dependent wildlife species.

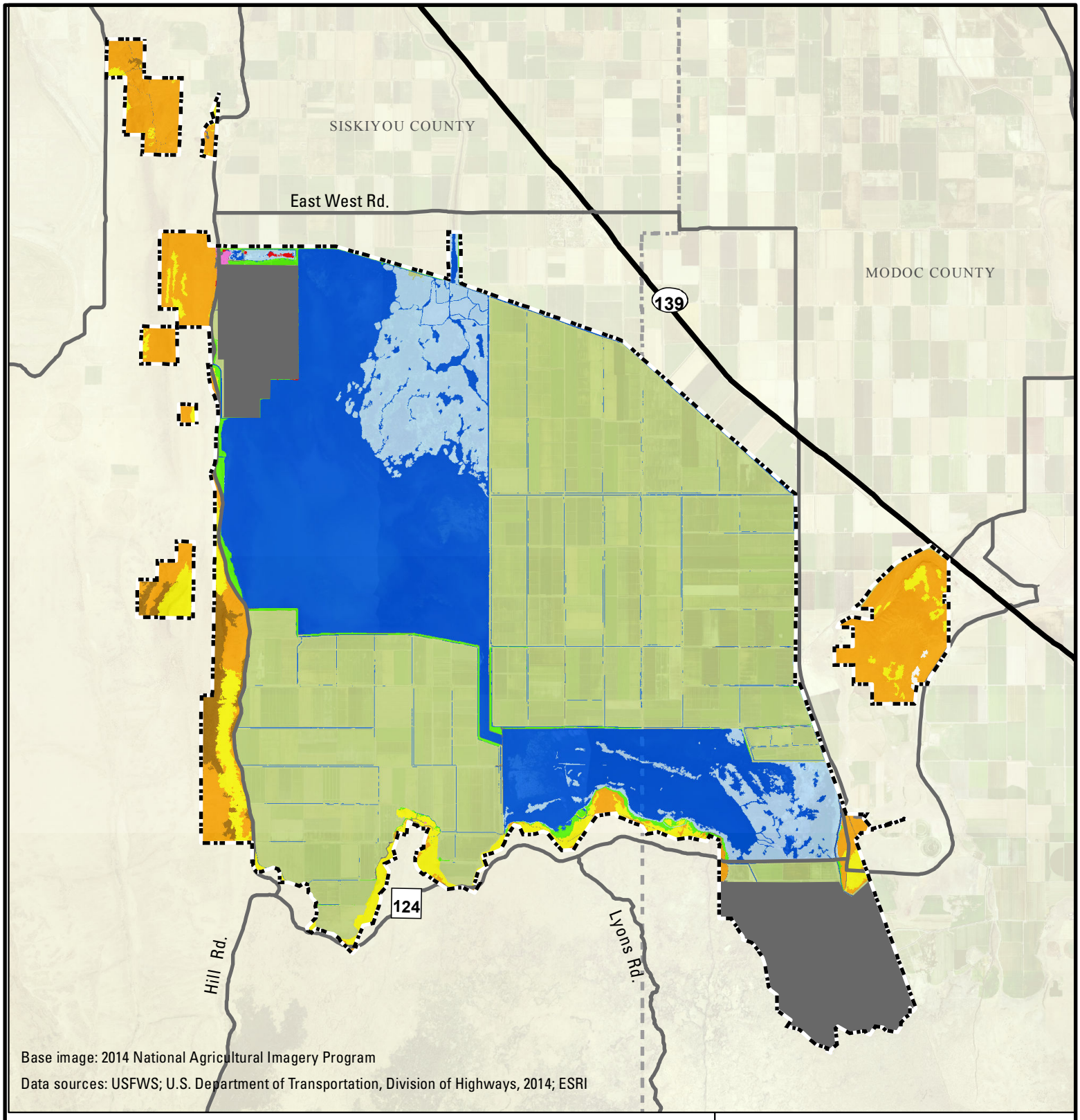


Figure 5.14. Vegetation - Tule Lake Refuge

Table 5.23. Tule Lake Refuge Estimated Production of Ducks, Coots, and Geese, 2008 through 2014

Year	*Duck*	*Coot*	*Goose*
2008	3,731	4,355	113
2009	9,310	4,216	145
2010	6,149	3,866	92
2011	4,516	2,356	198
2012	6,568	4,359	98
2013	4,857	3,999	91
2014	2,385	6,569	263
Average	**5,359**	**4,246**	**143**

Raptors

Tule Lake is an important foraging area for bald eagles wintering in the Klamath Basin. In addition, refuge uplands have vertical cliff faces supporting nesting and roosting sites for barn owls, red-tailed hawks, American kestrels, prairie falcons, and golden eagles.

Other Wildlife Species

Other wildlife species found in the area include jackrabbits, cottontail rabbits, coyotes, and mule deer (Reclamation and Service 1998). In addition, critical winter habitat for mule deer surrounds the refuge to the west, south, and east.

Federal- and State-Listed Species

*Applegate's **Milkvetch***

The endangered Applegate's milkvetch potentially occurs on Tule Lake Refuge given the occurrences within the vicinity, but there are no known modern occurrences.

Lost River and Shortnose Suckers

Lost River and shortnose suckers, both federally listed as endangered, are known to occur within the boundaries of Tule Lake Refuge. Historically, Tule Lake provided suitable habitat for a large population of shortnose and Lost River suckers (Service 1995). However, only a small remnant population of each remains due to the relatively small area of the lake greater than 3 feet deep and the poor water quality during the summer months.

In 2007, an intensive trap-netting effort was made in Tule Lake sumps to assess the presence and relative abundance of juvenile and sub-adult suckers. With over 1,000 hours of effort throughout both Sumps 1A and 1B, only two juvenile suckers were captured, suggesting little recent recruitment had occurred and that Tule Lake is primarily a refuge population for adult Lost River and shortnose suckers and unlikely supports self-sustaining sucker populations (Hodge 2008). Although few juveniles were found, the effort did capture hundreds of adult suckers of each listed species.

Gray Wolf

The endangered gray wolf (*Canis lupus*) is known to occur within the boundaries of Tule Lake Refuge.

Bald Eagle

Tule Lake is an important foraging area for bald eagles wintering in the Klamath Basin, which feed primarily on crippled or disease-weakened waterfowl. In addition, flood-irrigation in the Klamath Basin during the late winter months and spring provides opportunities for bald eagles to feed on displaced rodents, and the eagles may forage for fish in aquatic habitats (Keister 1981).

5.4.3 Cultural Resources

According to the *Klamath Basin National Wildlife Refuge Complex Cultural Resources Assessment* (Service 2011a), to date, recorded cultural resources known to be within 1 mile of the congressionally authorized boundaries of the Tule Lake Refuge consist of 57 recorded prehistoric sites (i.e., habitation sites, rockshelters, human remains, pictographs, midden, worked stone, stacked rock, bedrock mortars, house pits, groundstone, traditional use locus, cleared areas) and 12 recorded historic sites (i.e., structural remains, refuse scatter, battlefields, repatriation locus, Civilian Conservation Corps activity loci, Tule Lake Segregation Center). Although the area on and around Tule Lake was used extensively by Native Americans and there are an abundance of cultural resource sites, only one site has thus far been determined eligible for the NRHP, the Tule Lake Segregation Center. The Tule Lake Segregation Center is unique because it became the largest of the 10 War Relocation Authority camps and because it was used to detain those labeled as "disloyal." It was designated a National Historic Landmark in February 2006 because of its national importance in the historic context of Japanese Americans in World War II (NPS 2006). In December 2008, this site was declared a National Monument by Presidential Proclamation. The Tule Lake Segregation Center is **a 37-acre site owned by the NPS just north of Highway 139. Camp Tulelake, an NRHP-eligible property, is located southeast of Highway 139 on refuge property**. A more detailed discussion of the cultural resources within the Refuge Complex is included in Appendix O.

5.4.4 Visitor Services

Recreation opportunities on Tule Lake Refuge include the visitor center, wildlife viewing areas, a wildlife auto route, waterfowl hunting, photography blinds, and a canoe trail.

The refuge headquarters and visitor center is open Monday through Friday, 8:00 am to 4:30 pm, and weekends 9:00 am to 4:00 p.m. (except Thanksgiving, Christmas, and New Years' Day). The auto tour and interpretive areas around the visitor center of Tule Lake Refuge are open to the public year-round from sunrise to sunset. A canoe trail is open seasonally from July to September. Other areas of the refuge are closed to public entry to minimize disturbance to wildlife, except for units open to waterfowl and pheasant hunting during the state seasons.

<u>Environmental Education</u>

The Refuge Complex has developed a kindergarten through 12th grade birding curriculum and a kindergarten through 8th grade wetlands curriculum that is the basis for lessons that are taught

on-site and are specific to each refuge within the Refuge Complex. Although most of the learning takes place at the Lower Klamath and Tule Lake Refuges, there are lessons that include curriculum about all the refuges in the complex. Students are taught at the Dave Menke Education Center, which is a converted duck hospital across the street from the Visitor Center, on the Discovery Marsh Trail, Sheepy Ridge Trail, Lower Klamath and Tule Lake auto tours, and the visitor center. Approximately four times a year students are taught on the Canoe Trail at the Upper Klamath Refuge. Students are currently using only areas that are open to all public use. Currently the refuge is providing on-site education to approximately 1,500 students annually and works with approximately 15 local schools including charter schools, public schools, and community organizations.

The Refuge Complex provides off-site education to approximately 1,000 students annually at a variety of locations including the 6th grade forestry tour on BLM land in southern Oregon, local schools, and other local parks and federal lands. The 6th grade forestry tour is a combination of education stations and partners; over a 3-day period, every 6th grade class has the opportunity to participate in the lessons.

Hunting

Waterfowl

Tule Lake Refuge hunts include two large marsh units accessible by boats, a spaced-blind hunt in dry fields, and open free-roam areas offering field hunts over harvested grain and smaller marsh units. Waterfowl hunting includes geese, ducks (including mergansers), American coots (*Fulica americana*), common moorhens (*Gallinula chloropus*), and Wilson's snipe (*Gallinago gallinago*) on designated areas of Tule Lake Refuge. As used here, sport hunting means the pursuit and killing of game animals using shotgun, archery (bow and arrow), or falconry (hawk or falcon) methods primarily for the purpose(s) of recreation and/or food. Hunting can be an effective means to manage wildlife and/or habitat in certain circumstances; however, that is not its purpose here. This wildlife-dependent recreational use is supported by the following activities: boating and use of retrieving dogs.

The refuge is currently open for migratory game bird hunting (see Refuge-Specific Regulations for Hunting and Fishing, California at 50 CFR 32.24). The refuge offers a diversity of waterfowl hunting opportunities, including free-roam hunts in marshes (Sump 1A, north of buoys) and in fields over harvested grain (the League of Nations area). Additionally, hunters may shoot from spaced blinds (numbered posts in dry fields), from Frey's Island, and from Sump 1B (east of buoys). A daily lottery is used to select individuals who are allowed to hunt in these latter three areas. An annual lottery is also used to select individuals to participate in waterfowl hunting on opening weekend. There are six boat-launching and parking areas across the refuge that provide access to the marshes (in Sumps 1A and 1B). Parking areas are located at each of the boat launches and additional parking areas are located elsewhere across the refuge. A hunter information site (check station) is located in the League of Nations at the north end of County Road 103. Hunters can also drive a street-legal or off-road vehicle into all spaced blinds and field units at the League of Nations and Panhandle to set out and pick up decoys. These drive-in areas provide opportunities for mobility-impaired waterfowl hunters. Seasons, hours, bag limits, and other rules for waterfowl hunting on the refuge are the same as those published annually by the CDFW for hunting of migratory game birds (CDFW 2014).

The hunt zone at Tule Lake Refuge totals approximately 14,500 acres (Figure 5.15). This area comprises approximately 37% of the over 39,100 acres under Service management jurisdiction. The remainder of the refuge is closed to waterfowl hunting and serves as a sanctuary area for waterfowl and other wildlife during hunting season. The annual number of waterfowl hunters on the refuge in recent years has been relatively stable (varying from approximately 2,700 to 2,800 [Klamath Basin NWRC Waterfowl Hunt Surveys for 2010–2011, 2011–2012, and 2012–2013]) (Service 2010–2013).

This use also includes operation of an annual pre-season youth waterfowl hunt. This special hunt is scheduled by CDFW and usually occurs mid- to late September (14 days prior to the designated opening weekend of the general waterfowl hunting season) and on selected dates during the regular season. Youths age 15 or younger can participate in this youth hunt provided they are accompanied by an adult, age 18 or over. Adults cannot hunt during these special hunts. A special ladies' hunt is also held on the refuge in conjunction with one youth hunt during the regular season or on one day during the early part of the regular season. Ladies are allowed to hunt from 1p.m. until the end of the state's shooting time.

As a wildlife-dependent general public use, waterfowl hunting is to be given special consideration in refuge planning and management. When determined compatible on a refuge-specific basis, a wildlife-dependent use becomes a priority public use for that refuge and is to be facilitated, that is, strongly encouraged (National Wildlife Refuge System Administration Act of 1966).

Upland Game

Hunting for ring-necked pheasant (*Phasianus colchicus*) is offered on designated areas of Tule Lake Refuge during the state-regulated hunting season. CDFW regulations also allow upland game to be hunted using archery (bow and arrow) and falconry (hawk or falcon) methods. An SUP is required for this use.

Parking areas are located across the refuge and hunter access to individual fields is walk-in only. A hunter information site building (check station) is located in the League of Nations Unit at the north end of County Road 103. Pheasant hunting is permitted daily during the regulated season. Shooting times in designated areas on the refuge correspond to state regulations. Unless otherwise stated, season dates, hours, harvest limits, and other rules for hunting on the refuge are the same as those published annually by the CDFW for hunting of upland game (CDFW 2015).

Pheasant hunting is limited to the units of the refuge designated on Figure 5.15 as showing visitor services. The areas open to pheasant hunting total approximately 8,431 acres of the refuge (see Figure 5.15). This area comprises approximately 22% of the 39,117 acres of the refuge. The remainder of the refuge is closed to pheasant hunting. The annual number of pheasant hunters on the refuge in recent years has been relatively stable (averaging 20 hunters and 30 birds on opening day [Klamath Basin NWRC Upland Game Hunt Surveys for 2009–2010, 2011–2012, and 2014–2015]) (Service 2009–2015).

When compared with waterfowl hunting, these types of hunts are less popular on the refuge. In the last 6 years, annual hunter visits for pheasant averaged 250, according to the multi-year visitor use data. Together, these pheasant hunting visits represent less than 6.2% of the total number of visitors to the refuge in those years (Service 2003b).

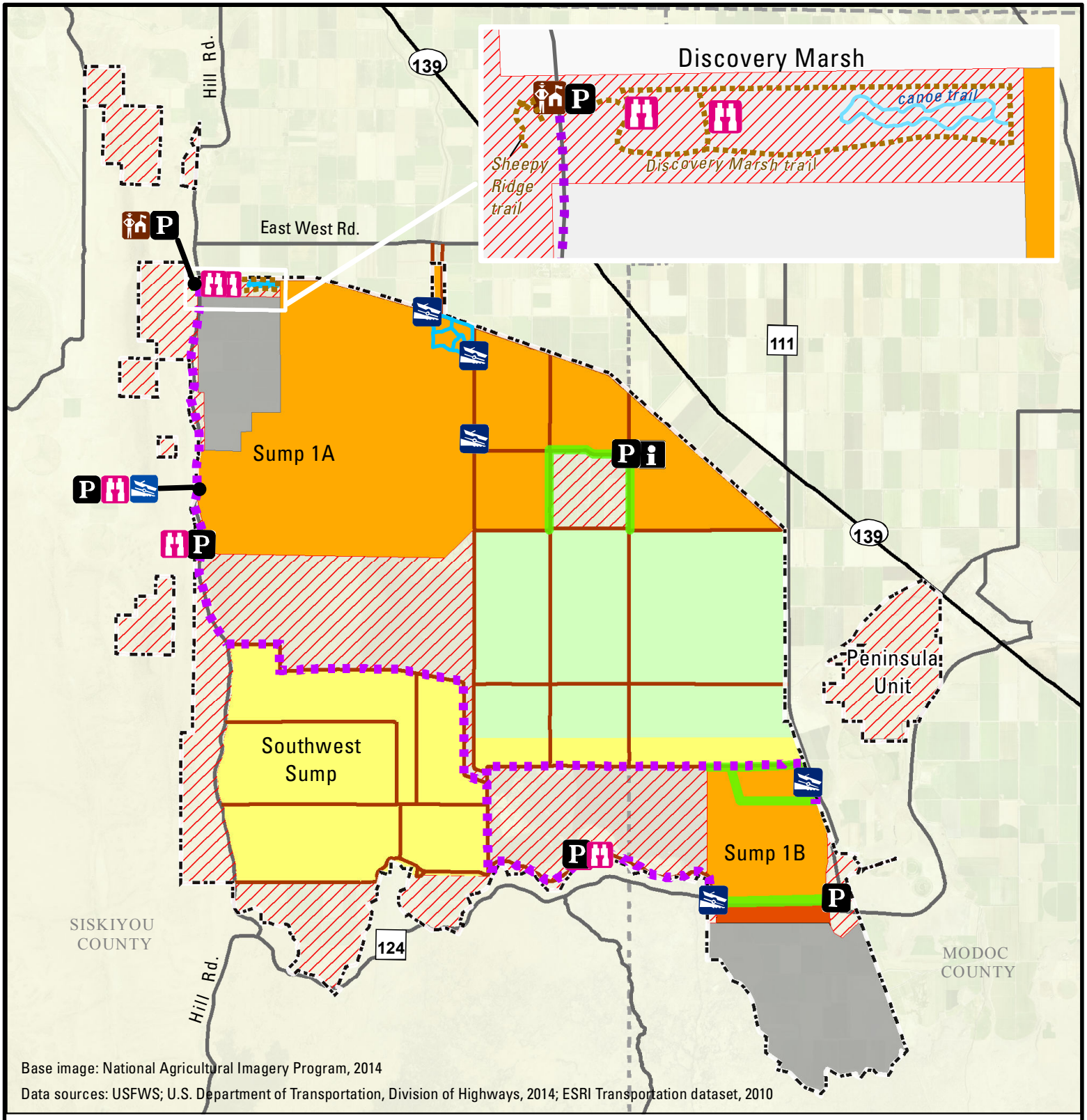


Figure 5.15. Visitor Services-Tule Lake Refuge

Guided Hunts

Commercially guided hunting and related services contribute to fulfillment of refuge purposes and to the NWRS mission by facilitating priority public use and management of healthy wildlife populations through controlled hunting. A competitive contract and SUP are required for this use.

Guided sport hunting is allowed in the areas open for that use as determined annually by the Service and described in the SUP. Guides are competitively selected to operate on refuge lands through a formal process established by regional policy. This policy manages commercial guiding activities at a level that is compatible with refuge purposes and that ensures high-quality guiding services are available for the public. Guide use areas on the refuge are not restricted and include all units open to waterfowl and/or pheasant hunting.

Typically, there are up to five hunting guides operating on the refuge under SUPs each hunt season. Guides must be qualified and licensed by the State of California and are required to submit in writing their experience, equipment, and safety plans, which are evaluated by Service personnel during the competitive selection process.

Waterfowl and pheasant are the target species. Between 2005 and 2014, guided recreational hunting for waterfowl on the refuge averaged about 150 client use days per season, with a high of 250 use days in 2006 and a low of 120 use days in 2014.

A majority of the permittees access the refuge by privately owned vehicles then launch motorized or non-motorized boats on the flooded wetlands within the refuge.

Wildlife Observation and Photography

Tule Lake Refuge is open to the public for wildlife observation and photography daily along the auto tour route with two viewing areas, two hiking trails, two canoe trails, and five photo blinds.

The auto tour route is 16.7 miles long and provides excellent opportunities to view large flocks of ducks and geese (spring/fall), white pelicans and western grebes (summer), and bald eagles and other raptors (winter). The auto tour route is an improved gravel road stretching along sections of Sump 1A and Sump 1B and winds through both wetland and upland habitats. There are two viewing areas: one is located on Hill Road at the beginning of the auto tour route where there is a parking area with an enclosed viewing platform giving views of Tule Lake Sump 1A. The second viewing platform is 7 miles into the auto tour route and is located on the south side of Sump 1B. This area provides a parking area along with an open viewing kiosk a short walk from the parking area. Both of the viewing platforms provide viewing opportunities for all types of waterfowl. The wildlife overlook and the wildlife observation platform are located in areas where visitors have the opportunity to see that the refuge is not entirely composed of wetlands. On the west side of Hill Road loom the rocky cliffs and uplands of Sheepy Ridge. During spring and summer many birds of prey nest here. Visitors can scan the rocks and small caves for red-tailed hawks, prairie falcons, and barn and great horned owls. In spring, large colonies of cliff swallows use these cliffs to attach their mud nests. In winter, bald eagles may perch here searching for waterfowl prey. Mule deer frequent the upper slopes of the ridge. Some of the fields along the auto tour route are cooperative farming units. The objective of these units is to provide nesting cover and food for migratory birds. In this program, farmers plant cereal grains such as barley, winter wheat, or oats. At harvest time, one third of the grain is left behind as food for migratory waterfowl. Green browse

such as winter wheat is planted during the fall migration to provide nutrient-rich food for Canada, white-fronted, snow, and Ross's geese. Coyotes can be seen year-round. Small diving ducks such as buffleheads and ruddy ducks can be seen along the auto tour route. From spring through fall visitors can see the western, Clark's, eared, and pied-billed grebes. Large flocks of Canada, snow, and white-fronted geese arrive in late winter and remain through spring on both the lake and in the fields.

Wildlife observation and photography opportunities are also available along the two hiking trails that are located near the Refuge Complex Visitor Center. The Discovery Marsh Trail meanders along the shore of a new marsh developed from farmland. Interpretive panels introduce the visitor to different wetland habitat types, waterfowl migration, and refuge management activities. A portion of the Discovery Marsh Trail is wheelchair-accessible. All other sections have a crushed gravel surface. The entire trail is completely level and allows for easy walking. The length of the trail to the first kiosk is 0.25 mile (round trip) and the distance to the second kiosk is 1.00 mile (round trip). The entrance to the Sheepy Ridge Trail is at the rear of the visitor center. The trail winds up to an observation structure built by the California Conservation Corps in 1936 as an access to the rock promontory there. The stone lookout was completed in 1938. All construction materials were hauled to the site by wheelbarrow. The stated purpose of the lookout was for the staff to observe Tule Lake Refuge but at the present time it is used primarily as a hiking trail for the public.

There are two canoe trails on the refuge. One canoe trail is located on the east end of Discovery Marsh and consists of approximately 2 miles of marked, quiet water channels within a 2,500-acre hardstem bulrush and cattail marsh. Wildlife viewing opportunities along the trail are excellent, especially during the morning and evening hours. Generally, the canoe trail is open from July 1 through September 30. However, it may be closed at any time to reduce disturbance to wildlife or due to fluctuating water levels. The canoe trail is open to non-motorized vessels during daylight hours only and public use is restricted to the designated trails. The second canoe trail is located on Tule Lake in the Sump 1A section of the refuge.

Five photo blinds are available for public use on the Tule Lake Refuge. Use of these blinds is by reservation only on a first-come, first-served basis and accepted only within 3 months of the first date the blind will be used. Just one blind may be reserved per day, and a given blind may be reserved for up to 2 days per week. An annual pass is required for anyone using the photo blind. Visitors may reserve this blind in person at the Refuge Complex Visitor Center, by telephone, or mail. Reservations made by telephone or mail should be made at least 10 days prior to intended use so that reservation materials will arrive by mail prior to use. Reservation confirmations are mailed when payment has been received. A season pass is available for $25.00 ($12.50 for those with the Golden Age, Senior Interagency or Interagency Access Pass). Full-time students also qualify for the half price passes. Reservation materials ask visitors to conduct their activities so as to keep wildlife disturbance to a minimum. Photographers are encouraged to enter blinds at or prior to sunrise which reduces disturbance and helps achieve the best results.

Hill Road Marsh Blind: This is a two-person blind with four lens ports located on the west shoreline of Tule Lake. From the Refuge Complex Visitor Center, this blind is 2.7 miles south on Hill Road to the boat ramp parking area on the left, where visitors can park at the ramp. The blind is a short walk (700 feet) out the dike on the north side of the boat channel. A minimum 200-mm lens is suggested. The blind faces the water in a north-northwest direction. The best seasons are spring, summer, and fall. During waterfowl hunting season (generally October through January)

the boat ramp area is used by hunters and fewer birds may be present. This blind is wheelchair accessible.

Tule Lake Sump 1B Raptor Blind: This one-person blind is set up to photograph hawks and eagles. It is located along the south shore of Sump 1B off the auto tour route. From the Refuge Complex Visitor Center, the blind can be located using the following directions: travel 4.8 miles south on Hill Road, then turn left (east) onto the auto tour route for 4.8 miles. At the "T" intersection turn right (south) for 1.2 miles and then left for 1.5 miles along the south shore of Sump 1B to the road signed for Authorized Vehicles Only. Turn left onto this road and travel 0.2 mile. Visitors can park at this location, leaving room for other vehicles to pass. The blind is approximately 200 yards to the north across the grassland near a tree (eagle perch). A minimum 300-mm lens is suggested. The blind faces north. The best months for visiting are December through mid-March. This blind must be entered before 7:00 a.m. from January through February.

Tule Lake Sump 1B Waterbird Blind: This blind accommodates up to two people. It is located on the south shore of Sump 1B along the auto tour route. From the Refuge Complex Visitor Center, the blind can be located using the following directions: travel 4.8 miles south on Hill Road, then turn left onto the auto tour route for 4.8 miles. At the tour route junction turn right for 1.2 miles and then left for 2.3 miles along the south shore of Sump 1B. You will see a boardwalk leading to the blind across the grasslands. Visitors can park there, leaving room for other vehicles to pass. A minimum 300-mm telephoto lens is suggested. The blind faces the water (north) with several openings to photograph waterbirds. The best seasons are spring and fall. This blind is wheelchair accessible.

Tule Lake Upland Blind: This one-person blind is being re-established after a wildfire destroyed the previous blind and surrounding habitat. As of fall 2014, the habitat is starting to recover and show signs of improvement. Photography opportunities will become more and more productive as time passes. This blind is located on the uphill side of Hill Road and is 7.4 miles south of the Refuge Complex Visitor Center. The blind is marked with a small white plaque marked with the number "4" and two red reflectors located on a power line support pole. Visitors can park off the pavement just north of the pole. The blind is on the uphill side of the road about 50 feet from the road edge. A small watering pool attracts passerine species to branches and rocks spaced 15 to 25 feet from the blind. The best seasons are spring, summer, and fall.

Tule Lake Eagle Blind: This new two-person blind has two viewing ports facing the raptor tree and three additional ports for other opportunities. From the Refuge Complex Visitor Center, the blind can be located using the following directions: travel 4.8 miles south on Hill Road, then turn left onto the auto tour route for 4.8 miles. At the tour route junction turn right for 1.2 miles and then left for another 2.7 miles along the south shore of Sump 1B. Visitors can park along the road at the white post marking blind #5, leaving room for other vehicles to pass. The blind is a 600-yard walk to the north. A minimum 300-mm telephoto lens is suggested. The lens opening in the blind faces a willow tree where raptors frequently perch during the winter months. The best months for visiting are mid-December through mid-March. This blind must be entered before 7:00 a.m.

Interpretation

Interpretation involves participants of all ages who learn about the complex issues confronting fish and wildlife resource management as they voluntarily engage in stimulating and enjoyable activities. First-hand experience with the environment is emphasized through periodic nature

interpretive programs conducted by refuge staff. However, presentation, audiovisual media, and exhibits are often necessary components of the interpretive program. At Tule Lake Refuge, the Service maintains public opportunities for nature interpretation through interpretive signs at the visitor center and along the Discovery Marsh trail, through brochures, maps and visitor information provided at the Refuge Complex Visitor Center, and on the website for the refuge. The Dave Menke Education Center is located at the visitor center and provides activities for both environmental education and interpretation.

Guided Wildlife Observation, Photography, and Interpretation

Permittee(s) are allowed to conduct commercial tours of either a for-profit or non-profit educational nature, and are allowed in public use areas where appropriate. With advance notice, the Dave Menke Education Center may be reserved. The focus of these tours may include wildlife observation, photography, and interpretation. Commercial tours may take from 1 day to multiple days and may involve multiple tour periods throughout the year as stated in the SUP. The refuge manager reserves the right to assign a staff member to accompany permittees(s) during tour operations.

Boating

Boating on Tule Lake Refuge consist of car-top, hand-launched boats, such as kayaks and canoes; boats with electric motors; and motorized boats powered by 2-cycle or 4-cycle gasoline engines. Air-thrust and inboard water-thrust (jet) boats are prohibited.

There are six boat launching and parking areas across the refuge that provide access to the marshes (in Sumps 1A and 1B). Boats may be used on all areas open to waterfowl hunting. The refuge is open to boating during the waterfowl hunt season from posted entry time to 2:30 p.m. Boat launching is not permitted after 1:00 p.m. and all boats must be removed from waterfowl hunt areas by 2:30 p.m. All state boating requirements are enforced by refuge officers.

Some boat-in areas are restricted to non-motorized boats only and these areas are open from sunrise to sunset. The non-motorized boating primarily occurs in two areas. The David Champine Canoe trail which is located in the eastern end of the second cell of Discovery Marsh (see Figure 5.15). This trail is open year-round, subject to the available of water. A canoe, paddles, and lifejackets are available for public checkout at the refuge visitor center. The canoe launch point is near the large rock dedication memorial just before the large open water portion of Tule Lake. A second canoe area is located in the northeast corner of Sump 1A where the Lost River channel enters the lake. This area is open between the end of the waterfowl nesting season and before the start of the hunting season (July 1 through September 30).

A yearly recreation pass is required to boat on Tule Lake Refuge. Boaters may pay in person at refuge headquarters or in advance with a credit card by phoning refuge headquarters (530)-667-2231 or on-line at: https://klamathbasinrecreation.com. All fees collected are kept at the Klamath Basin refuges and are used to improve the hunt program. Annual recreation passes are $25.00 ($12.50 for those with the Golden Age, Senior Interagency or Interagency Access Pass). Full-time students also qualify for the half price passes. Boaters must carry their recreation pass at all times in the field.

The portion of the refuge open to boating totals approximately 8,258 acres. This area comprises approximately 21% of the 39,100 acres under Service management jurisdiction. Excluding the

upland hunt units during the hunt season, the remainder of the refuge is closed to boating and all other public uses and serves as a sanctuary area for waterfowl and other wildlife.

Regulation of boating on the refuge is managed to minimize safety risks, as well as adverse effects on wildlife, habitat, and other recreational users, particularly those engaged in wildlife-dependent uses.

5.4.5 Management and Monitoring Practices

Habitat/Water Management

Tule Lake Refuge serves an important flood control function, and sump areas are managed under an agreement with Reclamation and the TID as return flow sumps, flood control sites, and wildlife habitat. Minimum water levels in the sumps are mandated by the 2013 BiOp to protect the endangered Lost River and shortnose suckers, as well as a 1956 contract between TID and Reclamation.

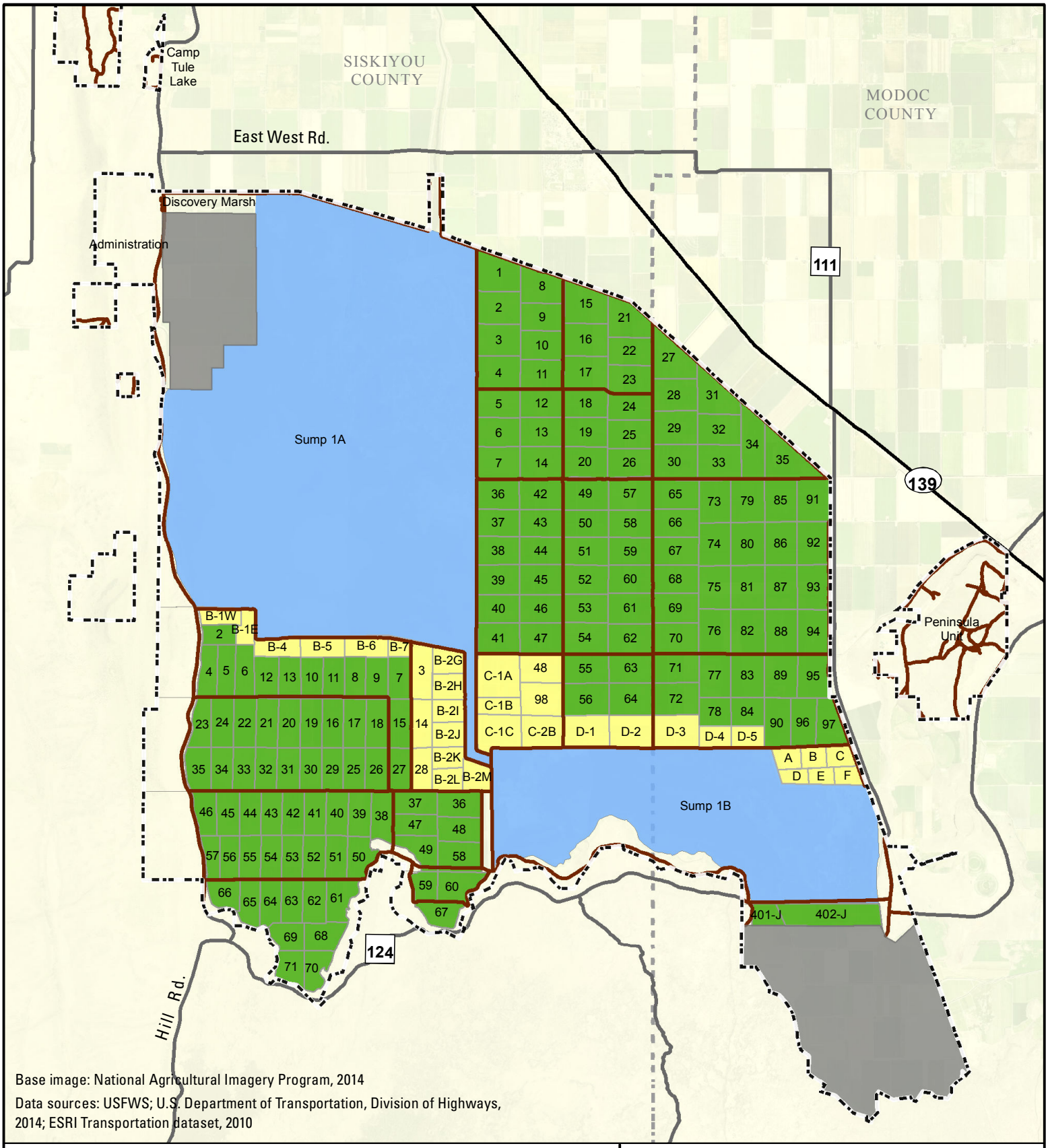
Lease Lands

Tule Lake Refuge consists of 39,116 acres of which 14,800 acres are leased to local farmers under a program administered by Reclamation via a 1977 Cooperative Agreement with the Service. The Kuchel Act provides that agricultural leasing on refuge lands must be consistent with proper waterfowl management and occur in specific locations. In addition, the Kuchel Act specifies that no more than 25% of the leased area can be planted to row crops and the leasing program is to seek maximum revenues, again consistent with waterfowl management. Leasing is by competitive bid with leases awarded in 5-year increments with the annual option to renew. Lease lands are comprised of 168 lots ranging from 60 to 120 acres each (Figure 5.16). Primary crops include barley, oats, wheat, onions, potatoes, and alfalfa. Barley, wheat, and oats comprise most of the acreage with potatoes the dominant row crop. In fiscal year 2015, gross lease revenues for Tule Lake Refuge totaled approximately $5.29 million (gross lease revenues for Lower Klamath Refuge totaled approximately $403,285). All revenues are collected by Reclamation, and distributed between local counties, TID, and Reclamation funds in accordance to federal laws.

Unlike the cooperative farming program, all crops are harvested leaving crop residues as a food resource for waterfowl.

The Tule Lake Refuge lease lands receive water from Upper Klamath Lake via Klamath Project facilities. The refuge exists within the TID and currently growers **on the lease lands and cooperative lands are required by their contracts with the United States to pay TID directly for the cost of irrigation and drainage service, which recently has been approximately $100 per acre.** The Service, however, owns the water rights on the refuge with a 1905 priority date for agricultural use. This water right (Claim 317) has a period of use from February 15 through November 15 on 16,000 acres for a total of 49,902 acre-feet of water (this water right includes cooperative farm lands). Most water is applied to the leased-lands from April through October. There is an increasing trend to pre-irrigate some lots in the fall and winter, a practice that both charges the soil profile with water for the subsequent farming season and increases the attractiveness of fields to waterfowl.

Typically, annual row crops, onions or potatoes, are grown in a 3-year crop rotation with small grains (e.g., small grain–row crop–small grain). Irrigation practices depend on the crop grown.



Base image: National Agricultural Imagery Program, 2014

Data sources: USFWS; U.S. Department of Transportation, Division of Highways, 2014; ESRI Transportation dataset, 2010

Approved acquisition boundary

Refuge road

Private land

Cooperative farming

Lease land farming

Wetland habitat

Figure 5.16. Lease Land and Cooperative Agriculture - Tule Lake Refuge

0 1 2 miles

Row crops are irrigated using solid set sprinklers. Irrigation events occur routinely on a 4- to 5-day schedule from June through mid-September. Alfalfa is flood irrigated with irrigation events following each harvest. Three or four irrigation events occur during the crop-growing season depending on harvest schedules. Small grains are flood or wheel line irrigated. There are usually two irrigation events for small grains, the first being a pre-plant irrigation typically starting in November.

A portion of the lease lands are managed as flood fallow units (termed "walking wetlands") on a 1- to 3-year basis. Periodically inserting wetlands into commercial crop rotations on the refuge as well as private lands has been found to suppress soil pathogens and weeds and enhance soil fertility and crop yields. This program provides an important tool in the expanding Klamath Basin organic farming effort, especially since no organic products are available to control weeds and organic fertilizers are expensive. Lease prices following the Walking Wetlands Program are substantially higher than prices paid for conventional farm fields.

The lease land program as applied to Tule Lake Refuge is described in detail in the IPM Plan (Service 1998a) and the associated environmental assessment.

Cooperative Farming

Cooperative farming is conducted on 2,250 acres divided among 18 lots (see Figure 5.16). In this program the grower does not make a lease payment to the government for use of refuge lands. Instead, a portion of the small grain crop is left standing for wildlife use. This percentage ranges from 25% to 33%. On cooperative farm lands, barley, oats, wheat, potatoes, and onions are currently allowed and the pesticide regulations discussed below apply.

As part of the private-lands Walking Wetlands (or Flood Fallow) Program, farm lots are awarded to growers based on their ability to provide wetlands on private lands. This allows them a tool to enhance agricultural (and wildlife) values on private lands and transition to organic crop production. A portion of the cooperatively farmed lands are also managed as wetlands on a 1- to 3-year basis. Periodically inserting wetlands into commercial crop rotations on the refuge as well as on private lands has been found to suppress soil pathogens and weeds and enhance soil fertility and crop yields. This program provides an important tool in the expanding Klamath Basin organic farming effort, especially since no organic products are available to control weeds and organic fertilizers are expensive. The Service is currently granting some longer term (more than 5-year) agreements with farmers with the provision that they transition to organic production using walking wetlands on both their private lands as well as refuge cooperative farm lands.

Cooperative farm lots are used extensively by fall and spring migrating waterfowl. This use is enhanced by the pre-irrigation of fields during the fall and winter period and the large acreage of unharvested grain. In addition, this program provides waterfowl a food resource away from private lands thus reducing the potential for crop depredation. Similar to the lease lands, water rights are held by the Service with a priority date of 1905 (Claim 317).

Vegetation Management

Burning, tillage, and irrigation in the fall are subject to refuge approval to ensure that waterfowl habitat values of farmlands are not compromised. In addition, burning or tillage of farm lands is not allowed until a determination is made as to available water for wetlands and farming (fall

tillage of small grains in particular has the potential to decrease the availability of waste grain for waterfowl). Burning and fall irrigation can affect use patterns of waterfowl, potentially increasing crowding and the subsequent potential for disease.

Integrated Pest Management

Noxious weed control through the establishment of more desirable, competitive plants is an ongoing program within the farming program. Establishment of more wildlife-beneficial habitats suppresses weed populations as well as provides enhanced habitat for ground-nesting birds and winter cover for other wildlife species. The Service works to scout, map, and control priority weeds especially in priority wildlife habitats and uses an IPM approach to control of invasive species. Practices followed include manipulation of water levels, tilling and disking, mowing, varying the timing of these practices, hand pulling of weeds, prescribed burning, bag-type repellents, trapping and removal, and application of pesticides. Pesticides are applied using hand wands or backpack sprayers; boomless sprayers mounted on all-terrain vehicles, utility-terrain vehicles, or trucks; and occasionally from aircraft.

Cooperative farmers are allowed to use the same suite of pesticides on the same pests with the same BMPs as those used by individuals farming the lease lands on the refuge (see Service and Reclamation 2015). Table 5.24 summarizes the types of pesticides authorized for use on refuge cooperative farmlands in 2015. Pesticide application on cooperative farm field is relatively minor. Table 5.25 provides a summary of the acreage treated with pesticides on cooperative farm fields between 2011 and 2015.

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Wheat, barley, oats, and potato	Blue alfalfa aphid	*Acyrthosiphon kondoi*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Wheat, barley, and oats	Oat-bird cherry aphid	*Rhopalosiphum padi*	Malathion 8 EC, Malathion 8 Aquamul, Fyfanon 8 Lb. Emulsion	Malathion
Wheat, barley, and oats	English grain aphid	*Macrosiphum avenae*	Malathion 8 EC, Malathion 8 Aquamul, Fyfanon 8 Lb. Emulsion	Malathion
Potato	Green peach aphid	*Myzus persicae*	Admire Pro, Alias 4F (MANA), Provado 1.6; Beleaf 50 SG; Cruiser 5FB; CruiserMaxx; Fulfill; Movento; PFR-97 20% WDG	Imidacloprid; flonicamid; thimethoxam; thimethoxam + fludioxonil; pymetrozine; spirotetramat; isaria fumosorosea Apopka strain 97
Wheat, barley, oats, and potato	Potato aphid	*Macrosiphum euphorbiae*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Potato	Potato aphid	*Macrosiphum euphorbiae*	Admire Pro, Alias 4F (MANA), Provado 1.6; Beleaf 50 SG; Cruiser 5 FB; CruiserMaxx; Fulfill; Movento; PFR-97 20% WDG	Imidacloprid; flonicamid; thimethoxam; thimethoxam + fludioxonil; pymetrozine; spirotetramat; isaria fumosorosea Apopka strain 97
Wheat	Russian wheat aphid	*Diuraphis noxia*	Dimethoate 400, Dimethoate 4EC	Dimethoate

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Potato	Beet armyworm	*Spodoptera exigua*	Dipel DF, XenTari; Success, Entrust; PyGanic Crop Protection EC 5.0	Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins
Potato	Fall armyworm	*Spodoptera frugiperda*	Success, Entrust; PyGanic Crop Protection EC 5.0	Spinosad; pyrethrins
Wheat, barley, and oats	Western yellow-striped armyworm	*Spodoptera praefica*	Success, Entrust;	Spinosad
Potato	Western yellow-striped armyworm	*Spodoptera praefica*	Avaunt; Dipel DF, XenTari; Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins
Wheat and barley	Cultivated barley	*Hordeum vulgare*	Cerone; Palisade 2EC	Ethephon; trinexapac-ethyl
Wheat, barley, and oats	Five-hook bassia	*Bassia hyssopifolia*	Affinity BroadSpec, Affinity TankMix; Clarity; Banvel; Dicamba Max 4; Harmony GT XP; MCP Amine 4, Rhomene MCPA; WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Weedone 638	Thifensulfuron-methyl + tribenuron-methyl; dicamba diglycolamine; dicamba dimethylamine; dicamba; thifensulfuron-methyl; MCPA dimethylamine; 2,4-D dimethylamine; 2,4-D butoxyethyl ester
Wheat and barley	Five-hook bassia	*Bassia hyssopifolia*	Express	Tribenuron-methyl
Potato	Five-hook bassia	*Bassia hyssopifolia*	Glory, TriCor DF, Metribuzin 75DF; Outlook, Sortie	Metribuzin; dimethenamid-p
Wheat, barley, and oats	Cereal leaf beetle	*Oulema melanopus*	Success, Entrust; Malathion 8 EC, Malathion 8 Aquamul, Fyfanon 8 Lb. Emulsion	Spinosad; malathion
Potato	Flea beetle	*Epitrix* sp.	Admire Pro, Alias 4F (MANA); Beleaf 50 SG; Cruiser 5 FB; CruiserMaxx; Success, Entrust; PyGanic Crop Protection EC 5.0	Imidacloprid; flonicamid; thimethoxam; thimethoxam + fludioxonil; spinosad; pyrethrins
Wheat, barley, and oats	Rhizoctonia aerial blight	*Rhizoctonia solani*	Rancona 3.8FS	Ipconazole
Potato	Early blight	*Alternaria solani*	Double Nickel 55; Endura; Kocide 2000, NU-COP 3L, Nu-Cop 50 DF, Champ WG, Nu-Cop 50 WP; Luna Tranquility; Quadris Flowable; Scala SC; Serenade Max, Serenade ASO	Bacillus amyloliquefaciens strain D747; boscalid; copper hydroxide; fluopyram + pyrimethanil; azoxystrobin; pyrimethanil; Bacillus subtilis QST 713 strain
Wheat, barley, and oats	Fusarium head blight	*Fusarium* spp.	Rancona 3.8FS	Ipconazole

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Potato	Late blight	*Phytophthora infestans*	Curzate 60DF; Double Nickel 55; Kocide 2000, NU-COP 3L, Nu-Cop 50 DF, Champ WG, Nu-Cop 50 WP; Nubark Mancozeb; Quadris Flowable; Ranman; Revus; Serenade Max, Serenade ASO	Cymoxanil; Bacillus amyloliquefaciens strain D747; copper hydroxide; mancozeb; azoxystrobin; Cyazofamid; mandipropamid; Bacillus subtilis QST 713 strain
Wheat and barley	Pythium blight	*Pythium* spp.	Apron XL	Mefenoxam
Potato	Purple blotch	*Alternaria porri*	Double Nickel 55	Bacillus amyloliquefaciens strain D747
Wheat, barley, oats, and potato	Downy brome	*Bromus tectorum*	Roundup PowerMAX, Alecto 41S	Glyphosate
Potato	Downy brome	*Bromus tectorum*	Glory, TriCor DF, Metribuzin 75DF; Matrix, Matrix SG; Outlook, Sortie; Poast; Roundup PowerMAX, Alecto 41S; Tapout	Metribuzin; rimsulfuron; dimethenamid-p; sethoxydim; glyphosate; clethodim
Potato	Stem canker	*Rhizoctonia solani*	Maxim MZ	Fludioxonil + mancozeb
Wheat, barley, oats, and potato	Alfalfa caterpillar	*Colias eurytheme*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Potato	Alfalfa caterpillar	*Colias eurytheme*	Dipel DF, XenTari	Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857
Potato	Army cutworm	*Euxoa auxiliaris*	Avaunt; Dipel DF, XenTari; Success, Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins
Potato	Black cutworm	*Agrotis ipsilon*	Avaunt; Dipel DF, XenTari; Success, Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins
Potato	Red-backed cutworm	*Euxoa ochrogaster*	Avaunt; Dipel DF, XenTari; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; pyrethrins
Potato	Spotted cutworm	*Amathes c-nigrum*	Avaunt; Dipel DF, XenTari; Success, Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins
Potato	Variegated cutworm	*Peridroma saucia*	Avaunt; Dipel DF, XenTari; Success, Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Wheat, barley, and oats	Flixweed	*Descurainia sophia*	Affinity BroadSpec, Affinity TankMix; Clarity; Banvel; Dicamba Max 4; Harmony GT XP; MCP Amine 4, Rhomene MCPA; WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Weedone 638	Thifensulfuron-methyl + tribenuron-methyl; dicamba diglycolamine; dicamba dimethylamine; dicamba; thifensulfuron-methyl; MCPA dimethylamine; 2,4-D dimethylamine; 2,4-D butoxyethyl ester
Barley	Flixweed	*Descurainia sophia*	Clarity; Banvel; Dicamba Max 4	
Wheat and barley	Flixweed	*Descurainia sophia*	Express	Tribenuron-methyl
Wheat, barley, oats, and potato	Flixweed	*Descurainia sophia*	Roundup PowerMAX, Alecto 41S	Glyphosate
Potato	Flixweed	*Descurainia sophia*	Glory, TriCor DF, Metribuzin 75DF; Matrix, Matrix SG; Outlook, Sortie	Metribuzin; rimsulfuron; dimethenamid-p
Potato	Fungus	*Fusarium* spp.	Regalia	Reynoutria sachalinensis extract
Potato	Barnyard grass	*Echinochloa crus-galli*	Poast; Tapout	Sethoxydim; clethodim
Wheat, barley, oats, and potato	Large crabgrass	*Digitaria sanguinalis*	Roundup PowerMAX, Alecto 41S	Glyphosate
Potato	Large crabgrass	*Digitaria sanguinalis*	Glory, TriCor DF, Metribuzin 75DF; Matrix, Matrix SG; Outlook, Sortie; Poast; Roundup PowerMAX, Alecto 41S; Tapout	Metribuzin; rimsulfuron; dimethenamid-p; sethoxydim; glyphosate; clethodim
Wheat, barley, oats, and potato	Witchgrass	*Panicum capillare*	Roundup PowerMAX, Alecto 41S; Matrix, Matrix SG	Glyphosate; rimsulfuron
Potato	Witchgrass	*Panicum capillare*	Glory, TriCor DF, Metribuzin 75DF; Outlook, Sortie; Poast; Tapout	Metribuzin; dimethenamid-p; sethoxydim; clethodim
Wheat, barley, and oats	Grasshopper	*unknown*	Malathion 8 EC, Malathion 8 Aquamul, Fyfanon 8 Lb. Emulsion	Malathion
Wheat, barley, and oats	Greenbug	*Schizaphis graminum*	Malathion 8 EC, Malathion 8 Aquamul, Fyfanon 8 Lb. Emulsion	Malathion
Wheat, barley, and oats	Lambsquarters	*Chenopodium album*	Affinity BroadSpec, Affinity TankMix; Clarity; Banvel; Dicamba Max 4; Harmony GT XP; MCP Amine 4, Rhomene MCPA; WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Weedone 638	Thifensulfuron-methyl + tribenuron-methyl; dicamba diglycolamine; dicamba dimethylamine; dicamba; thifensulfuron-methyl; MCPA dimethylamine; 2,4-D dimethylamine; 2,4-D butoxyethyl ester
Wheat and barley	Lambsquarters	*Chenopodium album*	Express	Tribenuron-methyl

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Wheat, barley, oats, and potato	Lambsquarters	*Chenopodium album*	Roundup PowerMAX, Alecto 41S	Glyphosate
Potato	Lambsquarters	*Chenopodium album*	Glory, TriCor DF, Metribuzin 75DF; Matrix, Matrix SG; Outlook, Sortie; Roundup PowerMAX, Alecto 41S	Metribuzin; rimsulfuron; dimethenamid-p; glyphosate
Wheat, barley, oats, and potato	Potato leafhopper	*Empoasca fabae*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Potato	Leak	*Pythium* spp.	Ridomil Gold Bravo, Ridomil Gold Bravo SC; Ridomil Gold MZ	Mefenoxam + chlorothalonil; mefenoxam + mancozeb
Wheat, barley, and oats	Prickly lettuce	*Lactuca serriola*	Affinity BroadSpec, Affinity TankMix; Clarity; Banvel; Dicamba Max 4; Harmony GT XP; MCP Amine 4, Rhomene MCPA; WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Weedone 638	Thifensulfuron-methyl + tribenuron-methyl; dicamba diglycolamine; dicamba dimethylamine; dicamba; thifensulfuron-methyl; MCPA dimethylamine; 2,4-D dimethylamine; 2,4-D butoxyethyl ester
Wheat and barley	Prickly lettuce	*Lactuca serriola*	Express	Tribenuron-methyl
Potato	Alfalfa looper	*Autographa californica*	Avaunt; Dipel DF, XenTari; Success, Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; Bacillus thuringiensis kurstaki, Bacillus thuringiensis aizawai strain ABTS-1857; spinosad; pyrethrins
Potato	Cabbage looper	*Trichoplusia ni*	Avaunt; Success, Entrust; PyGanic Crop Protection EC 5.0	Indoxacarb; spinosad; pyrethrins
Potato	Downy mildew	*Peronospora destructor*	Double Nickel 55	Bacillus amyloliquefaciens strain D747
Potato	Powdery mildew	Various spp.	Double Nickel 55	Bacillus amyloliquefaciens strain D747
Wheat	Brown wheat mite	*Petrobia latens*	Dimethoate 400, Dimethoate 4EC	Dimethoate
Potato	Botrytis gray mold	*Botrytis cinerea*	Double Nickel 55	Bacillus amyloliquefaciens strain D747
Potato	White mold	*Sclerotinia sclerotiorum*	Contans WG; Endura; Luna Tranquility	Coniothyrium minitans strain CON/M/91-08; boscalid; fluopyram + pyrimethanil
Potato	Black mustard	*Brassica nigra*	Glory, TriCor DF, Metribuzin 75DF; Matrix, Matrix SG; Outlook, Sortie	Metribuzin; rimsulfuron; dimethenamid-p
Potato	Columbia root-knot nematode	*Meloidogyne chitwoodi*	Garlic Barrier AG+; Movento; Telone II; Vapam HL; Vydate L, Vydate C-LV	Garlic juice; spirotetramat; 1,3-dichloropropene; metam sodium; oxamyl
Potato	Root lesion nematode	*Pratylenchus penetrans*	Movento; Telone II; Vapam HL; Vydate L, Vydate C-LV	Spirotetramat; 1,3-dichloropropene; metam sodium; oxamyl
Wheat and barley	Common wild oat	*Avena fatua*	Axial XL; Outlook	Pinoxaden; dimethenamid-p

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Wheat	Common wild oat	*Avena fatua*	Puma 1EC	Fenoxaprop-P-ethyl
Potato	Common wild oat	*Avena fatua*	Poast; Sortie; Tapout	Sethoxydim; dimethenamid-P; clethodim
Wheat, barley, and oats	Redroot pigweed (common amaranth)	*Amaranthus retroflexus*	Affinity BroadSpec, Affinity TankMix; Clarity; Banvel; Dicamba Max 4; Harmony GT XP; MCP Amine 4, Rhomene MCPA; WEEDestroy AM-40 Amine Salt, Weedar 64, Amine 4 2,4-D Weed Killer; Weedone 638	Thifensulfuron-methyl + tribenuron-methyl; dicamba diglycolamine; dicamba dimethylamine; dicamba; thifensulfuron-methyl; MCPA dimethylamine; 2,4-D dimethylamine; 2,4-D butoxyethyl ester
Wheat and barley	Redroot pigweed (common amaranth)	*Amaranthus retroflexus*	Express	Tribenuron-methyl
Wheat, barley, oats, and potato	Redroot pigweed (common amaranth)	*Amaranthus retroflexus*	Roundup PowerMAX, Alecto 41S	Glyphosate
Potato	Redroot pigweed (common amaranth)	*Amaranthus retroflexus*	Glory, TriCor DF, Metribuzin 75DF; Matrix, Matrix SG; Outlook, Sortie; Roundup PowerMAX, Alecto 41S	Metribuzin; rimsulfuron; dimethenamid-p; glyphosate
Wheat, barley, oats, and potato	Common pill bug	*Armadillidium vulgare*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Potato	Cultivated potato	*Solanum tuberosum*	ET; Rely 280, Reckon 280SL; Royal MH-30SG, Royal MH-30 Xtra	Pyraflufen-ethyl; glufosinate-ammonium; maleic hydrazide
Potato	Potato psyllid	*Paratrioza cockerelli*	Fulfill; PFR-97 20% WDG	Pymetrozine; isaria fumosorosea Apopka strain 97
Potato	Club root	*Plasmodiophora brassicae*	Regalia	Reynoutria sachalinensis extract
Potato	Pink rot	*Phytophthora erythroseptica*	Ranman; Ridomil Gold Bravo, Ridomil Gold Bravo SC; Ridomil Gold MZ	Cyazofamid; mefenoxam + chlorothalonil; mefenoxam + mancozeb
Potato	Root rot	*Pythium* spp.	Regalia	Reynoutria sachalinensis extract
Potato	Root rot	*Rhizoctonia* spp.	Regalia	Reynoutria sachalinensis extract
Potato	Root/crown rot	*Phytophthora* spp.	Regalia	Reynoutria sachalinensis extract
Potato	Bacterial stem rot	*Erwinia carotovora*	Tanos	Famoxadone + cymoxanil
Potato	White rot	*Sclerotia sclerotinia* [See 2015 PUP #296]	Contans WG	Coniothyrium minitans strain CON/M/91-08
Wheat, barley, and oats	Barley stripe rust	*Puccinia striiformis*	Quadris Flowable; Quilt, Quilt Xcel	Azoxystrobin; azoxystrobin + propiconazole
Potato	Common scab	*Streptomyces scabies*	Regalia	Reynoutria sachalinensis extract
Potato	Silver scurf	*Helminthosporium solani*	Maxim MZ	Fludioxonil + mancozeb
Wheat, barley, and oats	Seedling disease	Unknown	Charter; Raxil-Thiram Flowable Fungicide; RTU-Vitavax-Thiram	Triticonazole; tebuconazole + thiram; carboxin + thiram

Table 5.24. Tule Lake Refuge Cooperative Lease Land Farmlands: Crops, Pests, and Pesticides

	Pest		*Pesticide*	
Crop	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Wheat and barley	Seedling disease	Unknown	Charter F2; Dividend Extreme; Proceed MD, Proceed Concentrate	Triticonazole + metalaxyl; Difenoconazole + mefenoxam; prothioconazole + tebuconazole + metalaxyl
Wheat, barley, and oats	Seedling disease or decay	*Fusarium* spp.	Raxil XT Wettable Powder Fungicide; Tilt	Tebuconazole + metalaxyl; propiconazole
Potato	Seedling disease	*Fusarium* spp.	Maxim MZ; Nubark Mancozeb	Fludioxonil + mancozeb; mancozeb
Wheat, barley, and oats	Seedling disease	*Pythium* spp.	Raxil XT Wettable Powder Fungicide; Tilt	Tebuconazole + metalaxyl; propiconazole
Wheat, barley, and oats	Seed rot	*Aspergillus*	Rancona 3.8FS	Ipconazole
Potato	Brown spot	*Septoria glycines*	Luna Tranquility	Fluopyram + pyrimethanil
Wheat, barley, oats, and potato	Blue alfalfa thrip	*Acyrthosiphon kondoi*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Wheat, barley, oats, and potato	Onion thrip	*Thrips tabaci*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Potato	Onion thrip	*Thrips tabaci*	PyGanic Crop Protection EC 5.	Pyrethrins
Wheat, barley, oats, and potato	Potato thrip	*Macrosiphum euphorbiae*	Grandevo	Chromobacterium subtsugae strain PRAA4-1
Potato	Potato tuberworm	*Phthorimaea operculella*	Success, Entrust; PyGanic Crop Protection EC 5.0	Spinosad; pyrethrins
Wheat and barley	Cultivated wheat	*Triticum aestivum*	Cerone; Palisade 2EC	Ethephon; trinexapac-ethyl
Potato	Verticillium wilt	*Verticillium* spp.	Regalia; Telone II; Vapam HL	Reynoutria sachalinensis extract; 1,3-dichloropropene; metam sodium

Table 5.25. Pesticide Application on Cooperative Farm Fields

Year	*Acreage*
2011	532
2012	790
2013	407
2014	1735

As described in Section 5.1.9, Integrated Pest Management, pesticide applications will continue to be evaluated and permitted consistent with DOI and Service IPM and other relevant policies, and the PUP process. Table 5.26 lists the types of pesticides used or proposed for use to control invasive species as described in the wildlife, habitat, and facilities management programs in recent years (i.e., 2011–2015) at Tule Lake Refuge. Table 5.27 provides a summary of the acreage treated with pesticides for both habitat restoration and facility maintenance at the refuge.

Table 5.26. Tule Lake Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

	Invasive Species		*Pesticide*	
Habitat/Facility Type	*Common Name*	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Disturbed area and non-crop area	Five-hook bassia	*Bassia hyssopifolia*	Weedar 64; Makaze, Bly Star Plus	2,4-D dimethylamine; glyphosate
Aquatic and wetland	Five-hook bassia	*Bassia hyssopifolia*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4; Roundup Custom	Glyphosate; glyphosate + isopropylamine salt
Parking lot or roadside, and riparian	Five-hook bassia	*Bassia hyssopifolia*	Habitat, Ecomazapyr 2 SL; Gly Star Original	Imazapyr; glyphosate
Disturbed area, parking lot or roadside, and riparian	Five-hook bassia	*Bassia hyssopifolia*	Banvel; Vanquish	Dicamba dimethylamine; dicamba acid
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Five-hook bassia	*Bassia hyssopifolia*	E-2	2,4-D dimethylamine + fluroxypyr + dicamba
Disturbed area and non-crop area	Downy brome	*Bromus tectorum*	Weedar 64; Makaze, Bly Star Plus	2,4-D dimethylamine; glyphosate
Parking lot or roadside	Downy brome	*Bromus tectorum*	Matrix	Rimsulfuron
Parking lot or roadside, riparian	Downy brome	*Bromus tectorum*	Gly Star Original	Glyphosate
Aquatic and wetland	Cattail	*Typha* spp.	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4; Roundup Custom	Glyphosate; glyphosate + isopropylamine salt
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Common cocklebur	*Xanthium strumarium*	E-2	2,4-D dimethylamine + fluroxypyr + dicamba
Non-residential structure	Common earwig	*Forficula auricularia*	CY-KICK CS	Cyfluthrin
Parking lot or roadside	Flixweed	*Descurainia sophia*	Matrix	Rimsulfuron
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Poison hemlock	*Conium maculatum*	Weedar 64; E-2	2,4-D dimethylamine; 2,4-D dimethylamine + fluroxypyr + dicamba
Parking lot or roadside, riparian	Yellow iris	*Iris pseudacorus*	Habitat, Ecomazapyr 2 SL	Imazapyr
Aquatic and wetland	Yellow iris	*Iris pseudacorus*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4; Roundup Custom	Glyphosate; glyphosate + isopropylamine salt
Parking lot or roadside, riparian	Lambs-quarters	*Chenopodium album*	Habitat, Ecomazapyr 2 SL; Gly Star Original	Imazapyr; glyphosate
Parking lot or roadside	Lambs-quarters	*Chenopodium album*	Matrix	Rimsulfuron
Disturbed area, parking lot or roadside, and riparian	Lambs-quarters	*Chenopodium album*	Banvel; Vanquish	Dicamba dimethylamine; dicamba acid
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Lambs-quarters	*Chenopodium album*	E-2	2,4-D dimethylamine + fluroxypyr + dicamba
Parking lot or roadside, riparian	Purple loosestrife	*Lythrum salicaria*	Habitat, Ecomazapyr 2 SL	Imazapyr
Aquatic and wetland	Purple loosestrife	*Lythrum salicaria*	Rodeo, AquaMaster, AquaNeat, Glyphosate 5.4; Roundup Custom	Glyphosate; glyphosate + isopropylamine salt

Table 5.26. Tule Lake Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

	Invasive Species		*Pesticide*	
Non-residential structure	House mouse	*Mus musculus*	Maki Mini Blocks	Bromadiolone
Disturbed area and non-crop area	Common mullein	*Verbascum thapsus*	Weedar 64; Makaze, Gly Star Plus	2,4-D dimethylamine; glyphosate
Aquatic and wetland	Common mullein	*Verbascum thapsus*	Roundup Custom	Glyphosate + isopropylamine salt
Parking lot or roadside	Black mustard	*Brassica nigra*	Matrix	Rimsulfuron
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Black mustard	*Brassica nigra*	E-2	2,4-D dimethylamine + fluroxypyr + dicamba
Disturbed area and non-crop area	Tumble mustard	*Sisymbrium altissimum*	Weedar 64; Makaze, Gly Star Plus	2,4-D dimethylamine; glyphosate
Aquatic and wetland	Tumble mustard	*Sisymbrium altissimum*	Roundup Custom	Glyphosate + isopropylamine salt
Disturbed area and non-crop area	Stinging nettle	*Urtica dioica*	Weedar 64; Makaze, Gly Star Plus	2,4-D dimethylamine; glyphosate
Disturbed area and non-crop area	Perennial pepperweed	*Lepidium latifolium*	Weedar 64; Makaze, Gly Star Plus	2,4-D dimethylamine; glyphosate
Disturbed area, non-crop area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Perennial pepperweed	*Lepidium latifolium*	Weedar 64	2,4-D dimethylamine
Disturbed area, grassland, meadow or pasture, parking lot or roadside, and range	Perennial pepperweed	*Lepidium latifolium*	Telar XP	Chlorsulfuron
Disturbed area, meadow or pasture, parking lot or roadside, and range	Perennial pepperweed	*Lepidium latifolium*	AquaMaster, AquaNeat, Rodeo, Roundup PowerMAX, Roundup PROMAX, Ranger Pro, Alecto 41S	Glyphosate
Parking lot or roadside, riparian	Perennial pepperweed	*Lepidium latifolium*	Habitat, Ecomazapyr 2 SL	Imazapyr
Aquatic and wetland	Perennial pepperweed	*Lepidium latifolium*	Roundup Custom	Glyphosate + isopropylamine salt
Parking lot or roadside, and riparian	Redroot pigweed	*Amaranthus retroflexus*	Habitat, Ecomazapyr 2 SL; Gly Star Original	Imazapyr; glyphosate
Parking lot or roadside	Redroot pigweed	*Amaranthus retroflexus*	Matrix	Rimsulfuron
Disturbed area, parking lot or roadside, and riparian	Redroot pigweed	*Amaranthus retroflexus*	Banvel; Vanquish	Dicamba dimethylamine; dicamba acid
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Redroot pigweed	*Amaranthus retroflexus*	E-2	2,4-D dimethylamine + fluroxypyr + dicamba
Aquatic and wetland	Tumble pigweed	*Amaranthus albus*	Roundup Custom	Glyphosate + isopropylamine salt
Aquatic and wetland	Saltgrass	*Distichlis spicata*	Roundup Custom	Glyphosate + isopropylamine salt
Non-residential structure	Silverfish	*Lepisma saccharina*	CY-KICK CS	Cyfluthrin
Non-residential structure	Spiders	Multiple species	CY-KICK CS	Cyfluthrin
Aquatic and wetland	Common teasel	*Dipsacus fullonum*	Roundup Custom	Glyphosate + isopropylamine salt

Table 5.26. Tule Lake Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

	Invasive Species		*Pesticide*	
Fallow/former agricultural, disturbed area, meadow or pasture, parking lot or roadside, range, and riparian	Bull thistle	*Cirsium vulgare*	Milestone Specialty, Milestone VM	Aminopyralid
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Bull thistle	*Cirsium vulgare*	Weedar 64; E-2	2,4-D dimethylamine; 2,4-D dimethylamine + fluroxypyr + dicamba
Fallow/former agricultural, disturbed area, meadow or pasture, parking lot or roadside, range, and riparian	Canada thistle	*Cirsium arvense*	Milestone Specialty, Milestone VM	Aminopyralid
Disturbed area, meadow or pasture, parking lot or roadside, and range	Canada thistle	*Cirsium arvense*	AquaMaster, AquaNeat, Rodeo, Roundup PowerMAX, Roundup PROMAX, Ranger Pro, Alecto 41S	Glyphosate
Fallow/former agricultural, disturbed area, meadow or pasture, parking lot or roadside, range, and riparian	Scotch thistle	*Onopordum acanthium*	Milestone Specialty, Milestone VM	Aminopyralid
Disturbed area, grassland, meadow or pasture, parking lot or roadside, range, and riparian	Scotch thistle	*Onopordum acanthium*	Weedar 64; E-2	2,4-D dimethylamine; 2,4-D dimethylamine + fluroxypyr + dicamba

Table 5.27. Tule Lake Refuge Pesticides Applied for Habitat Restoration and Facility Maintenance

Year	*Acreage Applied*
2011	647
2012	1,158
2013	711
2014	2,004

Fire Management

The Refuge Complex has a long history of using prescribed fire and mechanical treatments to enhance habitats, supplement farming practices, and reduce wildfire risk to critical resources and communities. The lease land farming program accounts for the majority of prescribed burning on Tule Lake Refuge. Prior to planting, farmers request field burns to remove crop stubble, grasses, and weeds, and to release nutrients back into the soil. Lease land fields vary in size from 40 acres to over 300 acres and are generally surrounded by roads and canals. In the past, refuge firefighters conducted most of the prescribed burning on lease land fields; however, much is now done by contract.

Fire is also used on Tule Lake Refuge to burn off decadent marsh vegetation and open up new nesting areas for migratory waterfowl.

Fish and Wildlife Management

Wildlife Monitoring

Aerial bird surveys are conducted two times per month from September through April, and bird numbers are recorded by management unit. Species counted include all waterfowl, bald eagles, sandhill cranes, and white pelicans. In addition, refuge staff conducts spring and fall shorebird surveys on selected units of the refuge. These counts are important as they assist refuge managers in determining timing of wetland drawdowns for shorebird use. Additional surveys include waterfowl pair counts, waterfowl brood surveys, colonial waterbird surveys, tricolored blackbird surveys, eared grebe surveys, and others. These data in conjunction with the biologist's judgment are used in determining whether wildlife use is meeting goals for a particular habitat. Table 5.28 summarizes the period of record, frequency, and timing of current and historic surveys on Tule Lake Refuge.

Table 5.28. Tule Lake Refuge Period of Record, Frequency, and Timing of Current and Historic Surveys

Survey Name	*Start Year*	*End Year*	*Frequency of Survey*	*Survey Timing*	*Status*
Breeding Canada Goose Pairs	1950	Indefinite	Recurring - every year	Mid-March	Current
Breeding Duck Pairs Survey	1950	Indefinite	Recurring - every year	Mid-May	Current
Colonial Waterbird Surveys	1970	Indefinite	Recurring - every year	Methods and timing depend on the species	Current
Fall Staging Waterbird Survey	2011	Indefinite	Recurring - every year	Mid-August	Current
Mid-Winter Waterfowl Survey	1960	Indefinite	Recurring - every year	Early January	Current
Nongame Waterbird Breeding Population Survey	2011	Indefinite	Recurring - every year	Mid-June	Current
Periodic Waterfowl Surveys	1950	Indefinite	Recurring - every year	September–April	Current
Secretive Marshbird Surveys	2011	Indefinite	Recurring - every year	May–July	Current
Spring Shorebird Survey	2011	Indefinite	Recurring - every year	Late April	Current
Staging Black Tern Survey	2000	Indefinite	Recurring - every year	July–August	Current
Tule Goose Fall Survey	1995	2012	Recurring - every year	September	Historic
Vegetation Mapping	1992	Indefinite	Recurring - every year	August and September	Current
Water Records	1970	Indefinite	Recurring - every year		Current
Wintering Raptor Surveys	2011	Indefinite	Recurring - every year	January–February	Current
Wintering Tule Goose Survey	2000	Indefinite	Recurring - every year	October and November	Current

Disease Monitoring

Waterfowl diseases are a major concern on Tule Lake Refuge. Similar to other monitoring activities, disease data are collected by management unit. Ultimately, this information is used to determine if particular management activities precipitate disease outbreaks or if certain geographical areas are prone to disease.

5.5 Upper Klamath National Wildlife Refuge

Upper Klamath Refuge was established in 1928 as a preserve and breeding ground for wild birds and animals. It is composed of 23,098 acres of mostly freshwater marsh, open water, and uplands.

5.5.1 Physical Environment

Geographic Setting

Upper Klamath Refuge is located in Klamath County, Oregon, approximately 35 miles north of the California border (see Figure 1.6). It consists of 14,996 acres divided into three units: Hank's Marsh at the south end of Upper Klamath Lake, Upper Klamath Marsh Unit on the north western side of the lake, and Agency Lake and Barnes Ranches at the north end.

Geology

The Upper Klamath Lake basin was formed by block faulting and igneous activity and partially filled by sediment (i.e., cinders, ash, and pumice) carried by meltwater from the Cascade Range to the lake (Dicken 1980). The area is dominated by basalt flows and continental sedimentary rocks in graben-like structures produced by north-northwest-trending normal faults (McKee et al. 1983).

During the late Tertiary, the Klamath Basin may have drained south into the ancestral Pit River (Colman et al. 2004). Drainage was probably interrupted by early growth of the Medicine Lake volcanic field sometime in the late Pliocene or early Pleistocene (Colman et al. 2004; Donnelly-Nolan and Nolan 1986). Since then, Upper Klamath Lake has emptied into the Klamath River, flowing to the south and west.

Upper Klamath Lake remains tectonically active today (Colman et al. 2004). In 1993, two earthquakes, both with magnitudes of 6.0, occurred about 12.4 miles northwest of Klamath Falls, separated by a few hours, resulting in widespread damage and two deaths (Sherrod 1996).

Soils

Eight soil types underlie the Upper Klamath Refuge (Soil Conservation Service 1985; Soil Survey Staff 2008), two of which underlie the majority of the refuge. Histosols and Lather muck comprise 92% of the refuge. The refuge is composed of 7% water and the other six soil types make up 1% of the refuge (Figure 5.17). Both Histosols and Lather muck have poor potential for cultivated crops and for community use. However, they have good potential for developing shallow water areas for waterfowl. These soils are used by many ducks and geese for resting and feeding. Erosion potential from surface runoff is low because these soils have slopes of 0% to 1%. Histosols are not subject to wind-based erosion (ranked 0 on the NRCS Index). The Lather soils have a high potential for wind-based erosion and are ranked at level 5 (Figure 5.18).

Histosols, ponded: Histosols are soils that are dominated by organic matter. They are mostly soils that are commonly called bogs, moors, or peats and mucks. A soil is classified as a Histosol if it does not have permafrost and is dominated by organic soil materials. Histosols, ponded, are areas of marsh that have a floor of organic material. A portion of this area consists of scattered clumps of aquatic plants and small hillocks. The depth of water among the clumps and hillocks ranges from 0 to 3 feet. Histosols are 48% of the refuge.

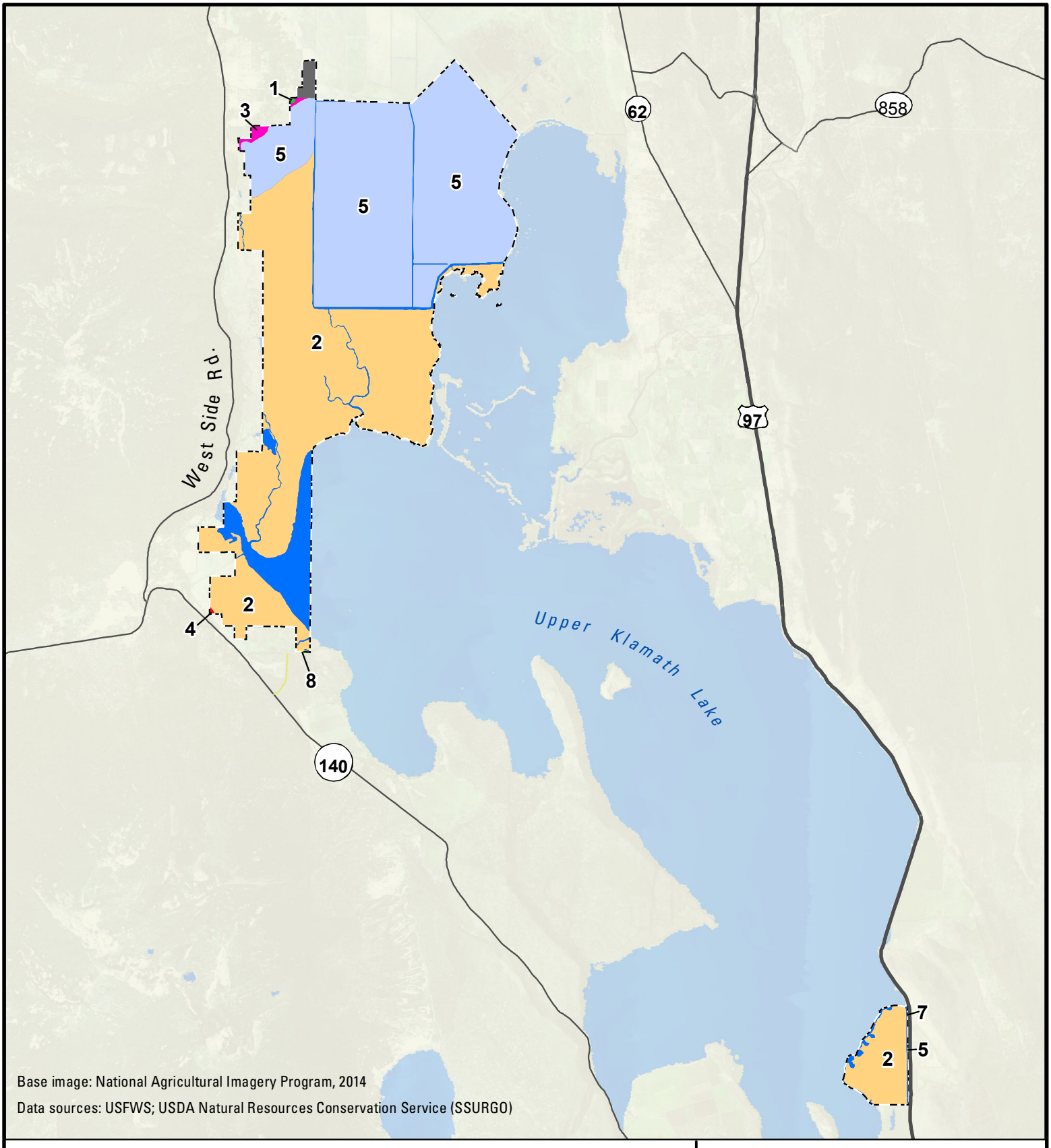
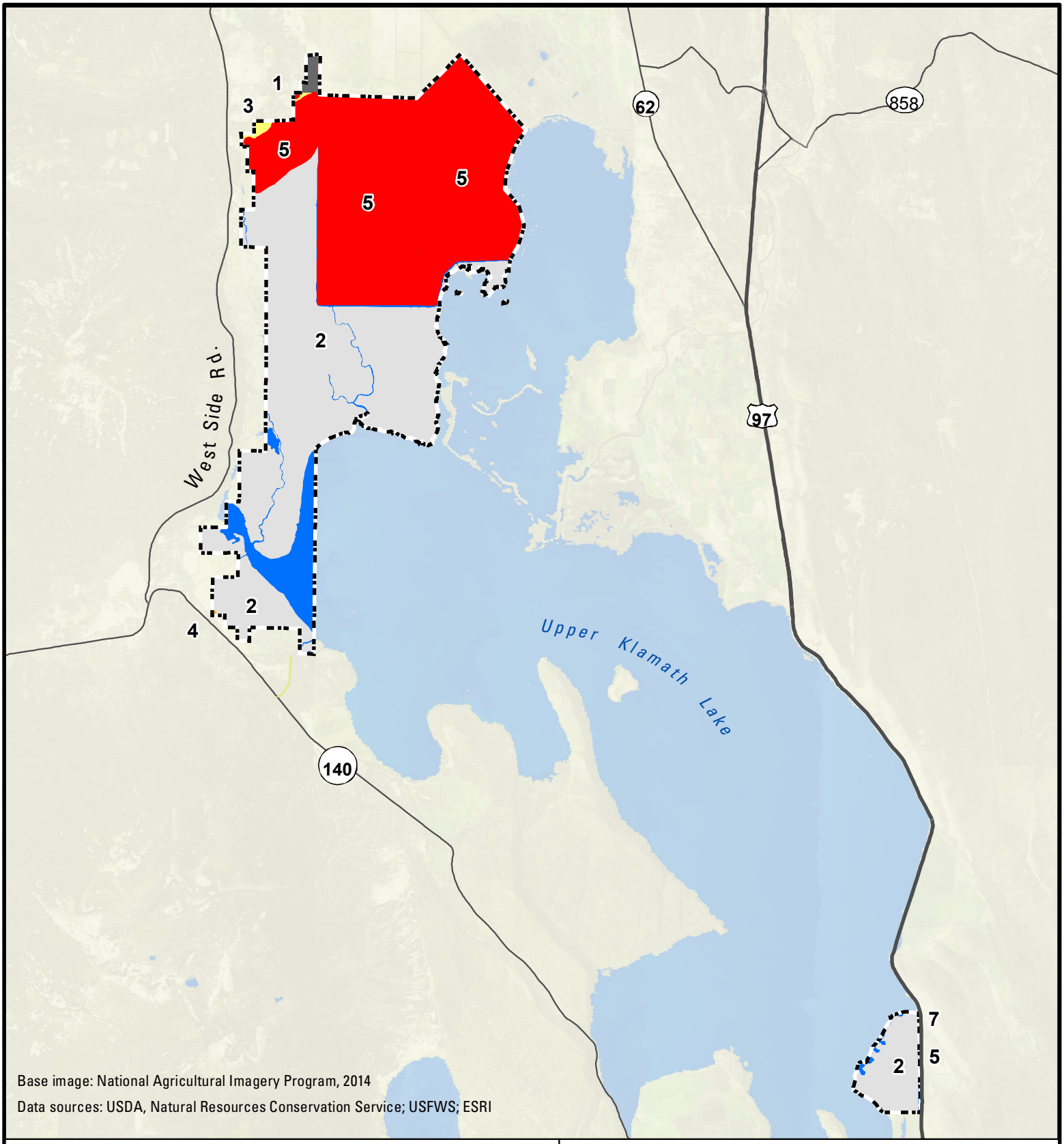


Figure 5.17. Soils-Upper Klamath Refuge



Base image: National Agricultural Imagery Program, 2014

Data sources: USDA, Natural Resources Conservation Service; USFWS; ESRI

Approved acquisition boundary

Water

Not classified

Soil Erodibility (scaled, low to high)	% of total area
0	51.9
1	0
2	0
3	0.4
4	0
5	47.7
6	0

Figure 5.18. Soil Erodibility from Wind - Upper Klamath Refuge

0 1.5 3 6 miles

N

Lather muck: The Lather series consists of deep, very poorly drained soils that formed in organic material with thin layers of silt. Lather soils are on drained marshes and have slopes of 0% to 1%. Soils in this series have an aquic moisture regime and are saturated with water throughout the year. These soils are formed in organic material from herbaceous plants containing thin layers of diatomaceous silt. Lather soils are either ponded or subject to very slow runoff. They have moderate permeability. These soils are used mainly for irrigated pasture and wildlife habitat. Within the refuge, these soils are used only for wildlife habitat. Native plants on these soils are mainly bulrush, tules, and lily. The Lather series is 44% of the refuge.

Hydrology

Upper Klamath Lake, which is the largest freshwater lake solely in Oregon, is very shallow and has extensive wetlands within and immediately adjacent to the natural lake area. Historically, up to 52,000 acres of marshland were associated with Upper Klamath Lake and up to 65,000 acres of open water at maximum capacity (Service 2008). Lake levels were controlled by two basalt reefs in the upper part of the Link River above the current location of the dam. Prior to construction of the dam and channelization of the reefs, lake levels varied from about 4,140 to 4,143 feet, with a mean annual variation of about 2 feet (Boyle 1976).

Today, Upper Klamath Lake remains the largest and highest large lake in the Klamath Basin system. The Wood, Williamson, and Sprague Rivers feed Upper Klamath Lake from the north and the lake is drained by the Klamath River to the south and west. Upper Klamath Lake is a large, shallow lake, with an average residence time of approximately 250 days.

The lake varies in width from about 6 to 14 miles and is about 25 miles long. The surface area of Upper Klamath Lake is about 96 square-miles, the mean surface elevation is about 4,140 feet above mean sea level, the mean depth is about 14 feet, and the maximum depth is about 49 feet (Oregon Lakes Association 2005). Reclamation maintains the surface elevation of the lake at 4,137 to 4,143 feet above mean sea level by virtue of a dam constructed in 1917 (Oregon Lakes Association 2005).

Upper Klamath Refuge emergent marshes exist above elevation 4,139.5 feet and are inundated when Reclamation-managed lake elevations exceed this level. Water within refuge wetlands is a mixture of the open waters of Upper Klamath Lake and water from a series of large springs on the west side of the marsh. There are no levees that allow for specific water level management of the marshes.

Water Quality

Currently, water quality in the Upper Klamath Lake is considered poor, primarily as a result of eutrophication. The source of excessive nutrients (primarily phosphorus) is believed to be a combination of relatively high background concentrations combined with nutrient inputs from anthropogenic factors. Phosphorus loading to Upper Klamath Lake is estimated as 61% from internal sources (sediment inputs from re-suspension) and 39% from external sources (ODEQ 2002). Rykbost and Charlton (2001) describe nutrient concentrations in Upper Klamath Lake at various times of the year (which increase through the summer) and describe nutrient concentrations and loads from Upper Klamath Lake that are due to both natural sources (spring and river inflows) and anthropogenic sources (conversion of wetlands and marshlands to agricultures, drainage of agricultural lands into Upper Klamath Lake, and increased internal loading).

The following information on water quality in Upper Klamath Lake has been excerpted primarily from the *Upper Klamath Lake Drainage Total Maximum Daily Load (TMDL) and Water Quality Management Plan (WQMP)* (ODEQ 2002).

Upper Klamath Lake is a hypereutrophic system (i.e., characterized by excessive nutrient concentrations and frequent severe algal blooms). Historical accounts indicate that the lake was considered eutrophic 100 years ago. However, since that time numerous land and water use changes have affected watershed hydrologic regimes and nutrient export characteristics of the drainage. Land use practices have also affected nutrient cycling and leaching through the loss of wetlands, both adjacent to the lake and in upstream watershed areas. The hydrology of the lake has been changed by increases in upland water yields, by extensive diking and draining of seasonal wetland/marsh areas, by water diversions from tributaries entering the lake, by diversion of water out of the lake, and by the construction of a dam at the lake's outlet that allows the lake to be operated as a storage reservoir. As a result, both the timing and quantity of the lake flushing flows and nutrient retention dynamics have been altered, and lake surface elevation and volume are seasonally reduced below historic levels.

There have also been major changes in management of the watershed resulting in degradation of riparian corridors, and the conversion of 35,000 acres of wetlands to pasture and agriculture on the lake periphery itself (Gearheart et al. 1995; Risley and Laenen 1998).

Total phosphorus is the identified pollutant that causes pH, dissolved oxygen, and chlorophyll-*a* water quality standard violations in Upper Klamath Lake. Lake total phosphorus is derived from internal (in lake) and external (upslope) sources that vary seasonally. Measured water quality standard violations are typically associated with excessive algal production. Extensive blooms of the cyanobacterium *Aphanizomenon flos-aqaue* cause significant water quality deterioration due to photosynthetically elevated pH (Kann and Smith 1993) and to both supersaturated and low dissolved oxygen concentrations (Kann 1993; Kann and Smith 1993). Adverse effects that detract from native fish survival and viability occur during periods of both high pH and low dissolved oxygen reach. These blooms are seasonally and spatially variable throughout the lake system.

Water bodies in the study area have regularly exceeded acceptable water quality standards for several parameters in the past (Water Quality Sub Team 2011). Section 303(d) of the federal Clean Water Act requires that water bodies that violate water quality standards, thereby failing to fully protect "beneficial uses," be identified and placed on a 303(d) list. The ODEQ 2010 Integrated Report Assessment Database contains information on Oregon's surface waters identified as water quality-limited that need or currently have TMDLs. Although the report is dated 2010, the 303(d) listing of impaired waters is current as of December 14, 2012, due to ongoing additions and assessments by ODEQ and EPA (ODEQ 2013). As shown in Table 5.29, several water bodies within the study area are listed as impaired for one or more parameters.

The Upper Klamath Lake TMDL was developed in 2002 to address the dissolved oxygen and pH problems. Development of the TMDL used a large database of lake and upland information that has been, and continues to be, collected by multiple academic efforts, government agencies and the Klamath Tribes.

Table 5.29. Section 303(d) Listed Water Bodies and Parameters for Study Area Water Bodies

Water Body	*Parameter*			
	Chlorophyll-a	*pH*	*Dissolved Oxygen*	*Temperature*
Upper Klamath Lake	X	X	X	
Agency Lake	X	X	X	
Fourmile Creek				X
Sevenmile Creek			X	

Source: ODEQ 2013

Upper Klamath Lake is hypereutrophic and regularly experiences massive blue-green algal blooms and water quality extremes (including high pH and ammonia concentrations, and widely variable dissolved oxygen concentrations) during the summer and fall. These degraded conditions are associated with unnaturally elevated inputs of nitrogen and phosphorus to the lake, and seasonally high water temperatures. Water quality degradation in the Upper Klamath Lake watershed has led to large-scale fish kills related to algal bloom cycles in the lake (Kann and Smith 1993 [from Service 1995]). These episodes have also been correlated with seasonally high temperatures and low lake levels. Toxins generated by the algae are tied to fish die offs in the lake, potentially including the suckers (VanderKooi et al. 2010).

In an attempt to compensate for wetland losses, both the federal government and private organizations have supported the purchase of former farmed and ranched wetlands and are reclaiming these areas as wetland. However, it is unknown what level of water quality improvement will result and how long it will take.

Fire History

Upper Klamath Refuge has little potential for wildfire as nearly all of the refuge lands are in permanent marsh. There have been two known wildfires since the 1928 inception of the refuge. The first occurred in 1968 and consumed approximately 20 acres. The fire was referenced in an annual narrative and few details are known. Based on the reported account, the fire most likely ignited in the upper expanses of the northernmost section of the refuge and was suppressed without additional incident. In July 2013, another wildfire occurred on 0.1-acre of refuge land in the northwest corner of the refuge, in the Barnes-Agency Unit.

5.5.2 Biological Resources

Vegetation and Habitat Resources

Upper Klamath Refuge consists of 24,762 acres divided into three units: Hank's Marsh (approximately 1,191 acres), Upper Klamath Marsh (13,775 acres), and the Barnes-Agency Unit (9,796 acres) (Figure 5.19).

Marshes of Upper Klamath Refuge represent some of the last remnant marshes adjacent to Upper Klamath Lake. These wetlands are dominated by several emergent plant species including sedges (*Carex* sp.) as well as wocus (*Nuphar* sp.), hardstem bulrush (*Scirpus acutus*), cattail (*Typha* sp.), burred (*Sparganium* sp.), and willow (*Salix* sp). Submergent plant species include coontail (*Ceratophylum demersum*), bladderwort (*Utricularia* sp.), and several species of pondweeds (*Potomgeton* sp.). Because there are no peripheral levees surrounding these wetlands, water levels are dictated by water levels in the open lake. Upper Klamath Refuge wetlands are flooded at lake levels above 4,139.50 feet.

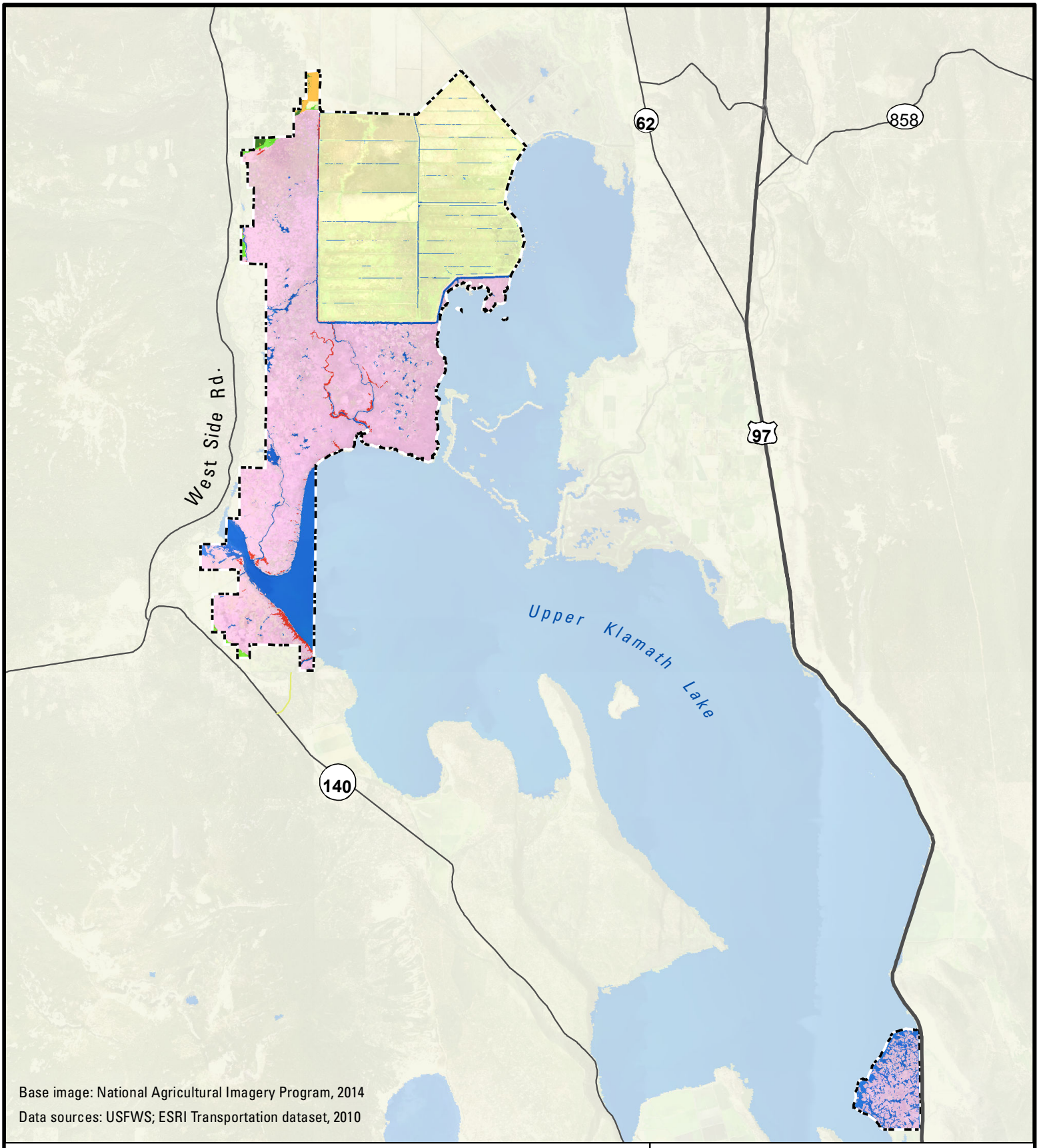


Figure 5.19. Vegetation - Upper Klamath Refuge

Wet meadow is the primary vegetation on both the Barnes and Agency Lake units (North State Resources, Inc. [NSR] 2007; Reclamation 2009). The majority of the Agency Lake unit (77%) supports wet meadow dominated by pale spikerush (*Eleocharis macrostachya*). This was interspersed with marshy areas supporting a number of species, including broadleaf cattail (*Typha latifolia*), needle spikerush (*Eleocharis acicularis*), water smartweed (*Polygonum amphibium*), and common duckweed (*Lemna minor*). Although almost the entire site contained these two wetland types, the percent cover and mixture of these species varied considerably across the property. More than 96% of Barnes Ranch Unit consists of wet meadow, with the remaining area being about 2% each waterways (ditches and drainage canals) and upland-dominated perimeter dikes. The property is dominated by Baltic rush (*Juncus balticus*), creeping spikerush, Nebraska sedge, and giant reed canarygrass (*Phalaris arundinacea*). Other plants found on the property included spreading bentgrass (*Agrostis stolonifera*), Kentucky bluegrass (*Poa pratensis*), annual hairgrass (*Deschampsia danthonioides*), broadleaf cattail, Geyer's willow (*Salix geyerana*), hardstem bulrush, water smartweed, curly dock (*Rumex crispus*), and golden dock (*Rumex maritimus*). Perimeter dike ditches supported primarily upland, weedy species, with a mixture of some hydrophytic (wetland) plants, including giant reed canarygrass, wooly mullein (*Verbascum thapsus*), sheep sorrel (*Rumex acetosella*), creeping thistle (*Cirsium arvense*), stinging nettle (*Urtica dioica*), yarrow (*Achillea millefolium*), spreading bentgrass, mountain tarweed (*Madia glomerata*), Kentucky bluegrass, prickly lettuce (*Lactuca serriola*), annual hairgrass, curly dock, and wood rose (*Rosa woodsii*) (NSR 2007).

Fish and Wildlife

Waterfowl and Other Waterbirds

The Upper Klamath Refuge is especially important in the Klamath Basin as a breeding area for several species of diving ducks, principally canvasbacks, redheads, and ringnecks. The emergent marshes on the refuge are the principal nesting areas for Canada geese in the Upper Klamath Basin (Table 5.30). In addition, the refuge represents one of the few remaining nesting areas for American pelicans in the western United States (three to five colonies are present each year).

A diverse array of waterbirds are also produced on the refuge. Upper Klamath Refuge supports large numbers of breeding western/Clark's grebes, American white pelicans, double-crested cormorants (*Phalacrocorax auritus*), and Forster's and black terns (Shuford et al. 2006). The refuge is also one of the principal nesting areas for black terns in the Klamath Basin.

During the late summer, Upper Klamath Refuge is a focal point for molting waterfowl. Waterfowl from throughout the Intermountain West and California spend this flightless period of the year in the emergent marshes of the refuge.

Upper Klamath Refuge is an important staging area for migratory waterfowl of the Pacific Flyway during both the spring and fall migration. The emergent vegetation is crucial to waterfowl during periods of inclement weather when conditions on the open lake are inhospitable. In 1997, waterfowl populations on the refuge peaked at 83,740 birds.

Table 5.30. Upper Klamath Refuge Estimated Production of Ducks, Coots, and Geese, 2008 through 2014

Year	*Duck*	*Coot*	*Goose*
2008	2417	1,353	610
2009	1,520	179	358
2010	2,735	389	806
2011	7,972	289	1,255
2012	2,216	857	1,290
2013	6,674	857	1,232
2014	502	2,142	1,580
Average	**3,434**	**867**	**1,019**

Mammals

Mammals in the area are primarily year-round residents typically found in agricultural areas, including coyote (*Canis latrans*), striped skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), opossum (*Didelphus virginianus*), muskrat (*Ondatra* spp.), and small mammals such as gophers, rabbits, ground squirrels, shrews, mice, moles, bats, and voles. Other mammals that use aquatic habitats in area are beaver (*Castor canadensis*), river otter (*Lutra canadensis*), and the introduced common muskrat (*Ondatra zibethicus*).

Reptiles and Amphibians

Amphibians that occur in the area include Pacific treefrog, which uses marshes, ditches, and streams. Reptiles, including the western skink and gopher snake, occur in drier, upland areas.

Fish

The Atlas of Oregon Lakes reports that two native species in the Cyprinidae family, blue chub (*Gila bicolor*) and tui chub (*Siphateles* [=*Gila*] *bicolor*), make up 90% of the fish population in Upper Klamath Lake (Portland State University [PSU] 2013). However, Simon and Markle (1997, as cited in NRC 2004) estimate that the introduced fathead minnow is currently one of the most abundant fish in Upper Klamath Lake and Agency Lake. A small number of white sturgeon (*Acipenser transmontanus*) were introduced into Upper Klamath Lake in the 1940s.

The Klamath Lake sculpin is thought to be the most abundant sculpin species in Upper Klamath Lake, with numbers estimated to be in the millions. This species occurs only in Upper Klamath Lake, Agency Lake, and springs and creeks that flow into the west side of Upper Klamath Lake (NRC 2004). This species can tolerate poor water quality conditions, particularly low levels of dissolved oxygen (NRC 2004).

Historic runs of anadromous fish (coho, Chinook, steelhead) in the Upper Klamath Basin no longer occur in the area due to impassable dams on the Klamath River (DeLong 1997).

The Klamath Basin redband trout, a subspecies of rainbow trout, is a state-regulated native game fish. Native (not stocked) rainbow trout found in rivers east of the Cascade Mountains are likely redband trout (ODFW 2016). Crystal and Recreation Creeks (just outside the refuge boundary) are used extensively by redband trout for thermal refugia in the summer. Thousands of redband trout use this habitat making this area one of the most important refuge habitats in the lake.

Redband trout also spawn at all springs with substrate along Crystal and Recreation Creek from October through February. The heaviest spawning occurs at Crystal Springs which supports a spawning population that likely ranges from 300 to 700 adult redband trout. In the summer, redband trout are known to use the cooler, spring-fed Williamson and Wood Rivers. This species is adfluvial and migrates into the Williamson and Wood Rivers from Agency Lake and Upper Klamath Lake to spawn.

Fishes, invertebrates, and water quality were studied from July 2003 to October 2005 at four locations in Upper Klamath Refuge marsh and in adjacent Fourmile and Odessa Creeks. A total of 82,595 fish, representing 17 species and eight families, were sampled using trap nets (Table 5.31). Yellow perch (*Perca flavescens*) and two cyprinids, the fathead minnow (*Pimephales promelas*) and the Tui chub (*Gila bicolor*), were the most numerous species in the sampling, representing 79% of all fish collected. Overall, nonnative species accounted for 63% of all the individuals collected. Few endangered suckers, Lost River (*Deltistes luxatus*) or shortnose (*Chasmistes brevirostris*), or rainbow trout (*Oncorhynchus mykiss*) were sampled (Mulligan and Mulligan 2007). However, methods used by Mulligan and Mulligan were not conducive to capturing adult or juvenile redband trout or adult suckers.

Upper Klamath Lake regularly experiences massive blue-green algal blooms and water quality extremes (including high pH and ammonia concentrations, and widely variable dissolved oxygen concentrations) during the summer and fall. Water quality degradation in the Upper Klamath Lake watershed has led to large-scale fish kills related to algal bloom cycles in the lake (Kann and Smith 1993 [from Service 1995]). These episodes have also been correlated with seasonally high temperatures and low lake levels. Toxins generated by the algae are tied to fish die offs in the lake, potentially including the [two listed] suckers (VanderKooi et al. 2010), addressed below.

Indirect effects of this eutrophication process on suckers in Upper Klamath Lake have been documented by Kann and Smith (1993). Water received into the Lower Klamath and Tule Lake Refuges from Upper Klamath Lake generally contains dense populations of blue-green algae, which can liberate microbially mediated production of nitrate and ammonia as cells grow and decompose (Maurer pers. comm., in Service 1995).

Federally Listed and State-Listed Species

Table 5.31. Upper Klamath Refuge Fishes Collected in Trap Nets in Six Locations in the Marsh and Adjacent Creeks, July 2003 through October 2005

Family	*Genus and Species*	*Common Name*		*Count*
Petromyzontidae	*Lampetra* (ammocete)	*		8
	Lampetra spp.	**		8
	Lampetra tridentata	Pacific lamprey		7
			subtotal	23
Cyprinidae	*Gila bicolor*	tui chub		20,041
	Gila coerulea	blue chub		2,952
	Pimephales promelas	fathead minnow		23,387
	Rhinichtys osculus	speckled dace		5,321
			subtotal	51,701
Catostomidae	*Chasmistes brevirostris*	shortnose sucker		25
Ictaluridae	*Ameiurus nebulosus*	brown bullhead		4,807

Table 5.31. Upper Klamath Refuge Fishes Collected in Trap Nets in Six Locations in the Marsh and Adjacent Creeks, July 2003 through October 2005

Family	*Genus and Species*	*Common Name*		*Count*
Salmonidae	*Oncorhynchus mykiss*	rainbow (redband) trout		9
	Salmo trutta	brown trout		1
	Salvelinus fontinalis	brook trout		1
			subtotal	11
Cottidae	*Cottus klamathensis*	marbled sculpin		115
	Cottus princeps	Klamath Lake sculpin		986
	Cottus tenuis	slender sculpin		827
			subtotal	1,928
Centrarchidae	*Lepomis gibbosus*	pumpkinseed		2,214
	Micropterus salmoides	largemouth bass		4
			subtotal	21,218
Percidae	*Perca flavescens*	Yellow perch		21,882
TOTAL				**82,595**

Source: Mulligan and Mulligan 2007

Bull Trout

Bull trout do not currently occur on the Upper Klamath Refuge. Recovery efforts that have been identified include restoring bull trout spawning/rearing habitats in the Wood River valley and reconnecting these habitats to Agency Lake, thereby restoring and reconnecting both occupied and unoccupied habitats in other areas. Reconnection of the Threemile Creek channel to Fourmile Creek/Fourmile Canal would potentially result in the connection of bull trout to habitat in Fourmile Creek. Reintroduction of bull trout into historic habitat of Cherry Creek (tributary to Fourmile Creek) is likely to occur in the foreseeable future. **However, bull trout designated critical habitat is in the lake itself, on or adjacent to Upper Klamath Refuge.**

Lost River and Shortnose Sucker

Lost River and shortnose suckers are endemic to the lake and tributary habitats of the Upper Klamath Basin. Shortnose suckers historically occurred in Upper Klamath Lake and its tributaries (Miller and Smith 1981; Williams et al. 1985) and other areas. Their primary rearing habitat is in Upper Klamath Lake (Service 2008). During the summer and early fall, Upper Klamath Lake water quality conditions periodically deteriorate to stressful and even lethal levels for suckers (see also *Water Quality*). Both suckers still occur in Upper Klamath Lake.

The Upper Klamath Lake Critical Habitat Unit 1 for Lost River and shortnose suckers includes Upper Klamath Lake and Agency Lake, the Link River and upper Klamath River downstream to Keno Dam, as well as portions of the Williamson and Sprague Rivers, for a total of approximately 90,000 acres and 120 river miles (NMFS and Service 2013). Agency Lake is in the northern arm of Upper Klamath Lake, connected by a narrow channel to the east of the refuge. The Upper Klamath Lake Recovery Unit encompasses most of the occupied range of the Lost River and shortnose suckers, including Upper Klamath Lake and the Klamath River downstream to Iron Gate Dam (Service 2013). This unit was occupied at the time of listing and contains those physical or biological features essential to the conservation of the Lost River sucker that may require special management or protection. The Upper Klamath Lake Critical Habitat Unit 1 contains areas for both river and spring spawning life histories for Lost River sucker, which are not known

to occur elsewhere throughout the range of the species. This unit is essential to shortnose sucker conservation because it supports the largest population of shortnose sucker and provides redundancy in the number of shortnose sucker populations that are needed for conservation. Additionally, this unit ensures shortnose sucker are distributed across various habitat types required by different life stages (*Federal Register* Vol. 77, No. 238, December 11, 2012).

Analysis of climatologic and hydrologic information for the upper Klamath Basin indicates Upper Klamath Lake inflows, particularly base-flows, have declined over the last several decades (Mayer and Naman 2011). Recent analyses completed for the 2013 BiOp (NMFS and Service 2013) confirm the trend in declining inflow to Upper Klamath Lake and also demonstrate declining flows in the Williamson and Sprague Rivers (major tributaries to Upper Klamath Lake) from 1981 through 2012. Net inflow to Upper Klamath Lake and flow in the Williamson and Sprague rivers are strongly dependent on climate, particularly precipitation (Mayer and Naman 2011). Part of the decline in flow is explained by changing patterns in precipitation; however, other factors are very likely involved as well, including increasing temperature, decreasing snow water equivalent, increasing evapotranspiration, or possible increasing surface water diversions or groundwater pumping upstream of the lake (Mayer 2008; Mayer and Naman 2011 [as cited in NMFS and Service 2013:245]).

In Upper Klamath Lake, the shortnose sucker population, which had increased substantially in the early 1990s, declined sharply between 1995 and 1997 because of die-offs. Since 1997, there has been no measurable recruitment, although in 2006 there was substantial production of shortnose suckers (Service 2008). Nevertheless, given that no substantial recruitment into the adult population of either species was detected in the subsequent decade, it appears that the cohort did not survive to reach adulthood. According to ODFW, the most used thermal refugia in the summer for adult suckers is the area near Pelican Bay and Fish Banks.

Oregon Spotted Frog

The Oregon spotted frog (*Rana pretiosa*) is listed as threatened under the federal ESA. Oregon spotted frog potentially occurs on Upper Klamath Refuge given occurrences within the vicinity, but there are no known modern occurrences. It has been reported to occur in the northeastern part of the Wood River Wetland (BLM 2009). Spotted frog egg masses have been observed near Jack Springs near Fourmile Springs. To date, no species-specific surveys have been done (Pearl pers. comm. 2015). There is no designated critical habitat within the boundaries of the refuge.

Gray Wolf

The endangered gray wolf potentially occurs on Upper Klamath Refuge given occurrences within the vicinity, but there are no known modern occurrences.

State-Listed and Other Special-Status Species

Special-status species that either have been documented on or are likely to occur on Upper Klamath Refuge include blue chub (*Gila coerulea*), marbled sculpin (*Cottus klamathensis*), mountain quail (*Oreortyx pictus*) (Oregon Sensitive Species [Northern Basin and Range Subregion] [OSS]), yellow rail (*Coturnicops noveboracensis*) (OSS, California Species of Special Concern [CSSC]), bald eagle (*Haliaeetus leucocephalus*) (Oregon Threatened) (California

Endangered [CE]), flammulated owl (*Otus flammeolus*) (OSS), great gray owl (*Strix nebulosa*) (OSS, CE), Lewis's woodpecker (*Melanerpes lewis*) (OSS), white-headed woodpecker (*Picoides albolarvatus*) (OSS), black-headed woodpecker (*P. arcticus*) (OSS), olive-sided flycatcher (*Contopus cooperi*) (OSS, CSSC), and willow flycatcher (*Empidonax traillii*) (OSS, CE).

Greater Sandhill Cranes

Two to four pairs of greater sandhill cranes breed on the Upper Klamath Refuge each year.

Great Gray Owl

The great gray owl is rarely observed on the refuges in the Refuge Complex. In addition to wintering bald eagles, the Klamath Basin hosts large numbers of nesting eagles particularly around Upper Klamath Lake. Upper Klamath Refuge also provides foraging habitat for nearby nesting bald eagles. Multiple special-status species may occur on, but have not been documented on, Upper Klamath Refuge, and are discussed in Appendix H.

5.5.3 Cultural Resources

As described in the *Upper Klamath Lake National Wildlife Refuge Cultural Resources Review for Comprehensive Conservation Planning* (Service 2007c), within the vicinity of Upper Klamath Refuge there are 13 recorded prehistoric sites, two recorded historic sites, and seven recorded sites of either unknown age or undetermined age. Only one of these sites is located within the refuge boundary and all others are located within 1 mile of the refuge. None of these sites have been formally evaluated for eligibility to the NRHP. Much of the refuge consists of marshlands, making the process of site discovery difficult. Since the time of prehistoric occupation the water level in Klamath Lake has risen considerably for the purpose of local agriculture, flooding an unknown quantity of sites. Discovery of these sites is unlikely by standard surface survey. It is probable that in the future archaeological sites will be exposed by natural or human actions. A more detailed discussion of the cultural resources within the Refuge Complex is included in Appendix O.

5.5.4 Plant Gathering

Floating leaf vegetation called wocus (wokas) or Rocky Mountain pond-lily (*Nuphar lutea* ssp. *polysepala*) (synonym of *Nymphaea polysepala*) is a native plant growing within the marsh on Upper Klamath Lake. Wocus has been gathered in and around the Klamath Lakes area by Native Americans historically (Coville 1897) and continues to be a periodic use today. The water lily, known by the Klamath Tribes as wocus, is of great cultural importance, and it is has been gathered for subsistence food for thousands of years (Coville 1904). Historically, seeds from the wocus formed a dietary staple of the Klamath Tribes.

The use of refuge lands for plant gathering is important to Native American cultural groups. In late summer (July through September), members of the Klamath Tribe gather seeds of wocus within the extensive network of open water areas of the marsh. The amount of plant material being harvested is typically small, approximately 1 to 2 acres, and is not expected to increase. The refuge contains approximately 15,000 acres of wetlands, of which about 70 acres support wocus. Wocus gathering is allowed on those areas of the refuge that are also open to the public for wildlife-dependent recreational use. Based on past use, it is estimated that less than 25 users per year would directly pursue this activity.

Gatherers typically use canoes to gather wocus from Upper Klamath Lake. The Wocus Cut Trail is a boat trail within the marsh designated for non-motorized boat use only. Approximately 90% of those canoeing at Upper Klamath Lake access the Wocus Cut Trail at the Rocky Point boat launch (a paved launch) and day use area on the west side of the lake (Johnson pers. comm. 2015). Upper Klamath Refuge is open to canoe access year-round; however, the lake ices over in the winter. Approximately 75% of all boaters (motorized and non-motorized) launch from the developed Rocky Point boat launch; others launch from the shallower Malone Springs launch (a dirt/gravel launch) (Johnson pers. comm. 2015).

5.5.5 Visitor Services

Hunting

The refuge is currently open for migratory game bird hunting (see Refuge-Specific Regulations for Hunting and Fishing, Oregon at 50 CFR 32.56). The hunt zone totals almost 9,100 acres, including Hank's Marsh; and the northern, eastern, and southern portions of the emergent marsh in the northwest corner of Upper Klamath Lake (Figure 5.20). This total area comprises approximately 39% of the almost 23,100 acres under Service management jurisdiction. The remainder of the refuge is closed to migratory bird hunting and serves as a sanctuary area for waterfowl during the hunting season.

The Service allows sport hunting for waterfowl, including geese, ducks (including mergansers), American coots (*Fulica americana*), common moorhens (*Gallinula chloropus*), and Wilson's snipe (*Gallinago gallinago*), on designated areas of Upper Klamath Refuge. As used here, sport hunting means the pursuit and killing of game animals by means of a shotgun, archery (bow and arrow), or falconry (hawk or falcon) primarily for the purpose(s) of recreation and/or food. Hunting can be an effective means to manage wildlife and/or habitat in certain circumstances; however, that is not its purpose here. This wildlife-dependent recreational use is supported by the following activities: boating and use of retrieving dogs.

Waterfowl hunters primarily use boats to access the refuge, with perhaps 75% launching from Rocky Point and a smaller number from Malone Springs. Both of these boat launches are on the western shore of Upper Klamath Lake, adjacent to the refuge, and on the Fremont-Winema National Forest. A few waterfowl hunters also launch from state parks on the eastern shore of Agency Lake and a small number boat into the Hank's Marsh Unit (from Hagelstein County Park or Pelican Marina) on the eastern shore of Upper Klamath Lake. Hunters are encouraged to use boats with reliable motors and decoys when waterfowl hunting on the refuge. When lake levels are low, it can be difficult to access the marsh, resulting in reduced numbers of waterfowl hunters. There is no vehicle parking, overnight camping, or other public use facilities on the refuge. Compared with Lower Klamath and Tule Lake Refuges, the number of waterfowl hunters visiting Upper Klamath Refuge is quite low (approximately 240–500 in a typical year according to recent Refuge Complex data [Service 2003b]). Due to the size of the hunt area and the relatively low numbers of hunters, conditions are generally uncrowded, potentially providing a higher-quality waterfowl hunting experience than on some other areas. Non-toxic shot is required. All hunting blinds, decoys, boats, and other personal property must be removed at the end of each day. Waterfowl hunting remains fair to poor and there are no known (permitted) guided hunt operations on Upper Klamath Refuge.

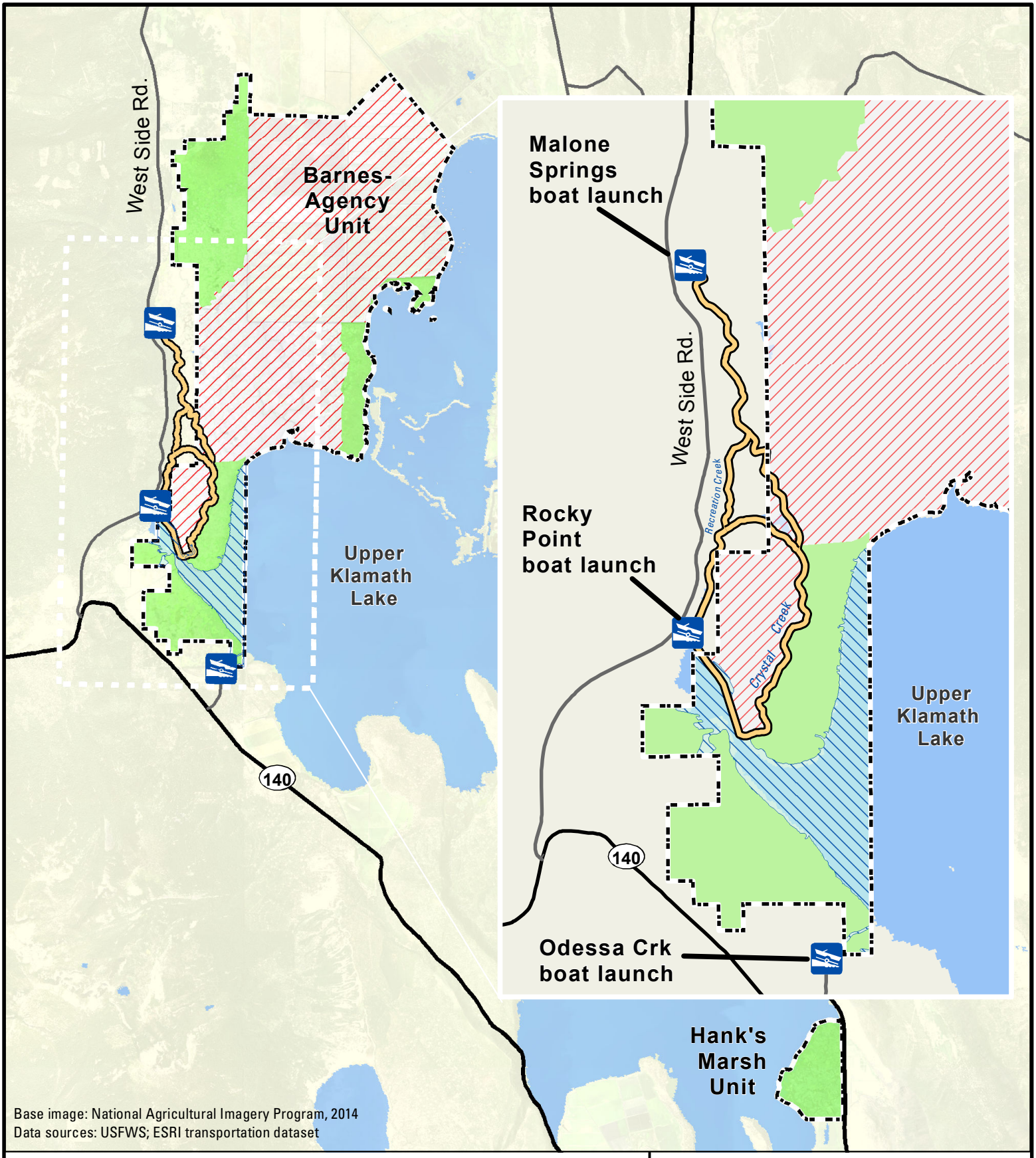


Figure 5.20. Visitor Services - Upper Klamath Refuge

The ODFW conducts an annual, pre-season youth waterfowl hunt on Upper Klamath Refuge. State employees may access the refuge and the Service provides no logistics or personnel. This special hunt usually occurs during the middle or end of September (prior to the start of the general waterfowl hunting season). Youths age 15 or younger can participate in this youth hunt provided they are accompanied by an adult, age 21 or over. Adults cannot hunt during this season.

The seasons, hours, bag limits, and other rules for waterfowl hunting on the refuge are the same as those published annually by ODFW for hunting of migratory game birds (ODFW 2016b). At present, waterfowl hunting is allowed on the refuge 7 days per week within the state-established season (generally October through January).

Upper Klamath Refuge consists entirely of marsh and is accessible only by boat. The main hunting area is near Rocky Point on the west side of Upper Klamath Lake. Small marsh pothole openings and hunting the marsh edge along the lake can provide good hunting for both dabbling and diving ducks. Canada and white-fronted goose hunting can also be good early in the season.

The primary species taken are mallard, gadwall, pintail, wigeon, green-winged teal, and lesser scaup.

Fishing

Recreational fishing is described as the activity of attempting to catch fish for sport, or pleasure, but not for sale or other commercial use. Fishing is often enjoyed by individuals or small groups of friends and/or family.

The Upper Klamath Refuge is composed of about 25,000 acres of primarily freshwater marsh. The marsh is a mosaic of dense emergent vegetation, dominated by hardstem bulrush or tules (*Schoenoplectus acutus*) and narrowleaf cattail (*Typha* sp.), and open water. The best fishing access is from a boat, canoe, or kayak. A 9.5-mile, marked canoe trail through the marsh is open year-round to non-motorized watercraft.

Within the refuge boundary on Upper Klamath Lake, recreational fishing is primarily done from boats. Two boat launches on the western shore of Upper Klamath Lake are the primary access points to the western portions of the refuge. Rocky Point and Malone Springs boat launches and their associated day-use areas are operated and maintained by the U.S. Forest Service and are open to public use free of charge. In 2014, the Refuge Manager estimated that 75% of the boaters on Upper Klamath Lake (including anglers) use the Rocky Point boat launch (paved boat ramp); the remaining 25% use the Malone Springs boat launch (shallow, gravel launch area).

Fishing is permitted on designated areas of the refuge in accordance with state laws and regulations subject to the stipulations herein. Fishing is permitted in Pelican Bay, Recreation Creek, Crystal Creek, Odessa Creek, Pelican Cut, and portions of Upper Klamath Lake.

Oregon State Fishing Regulations guide fishing on the all waters of the Klamath Basin in Klamath and Lake Counties including Upper Klamath Lake and its tributaries. The regulations are available online at: http://www.dfw.state.or.us/resources/fishing/index.asp#rules. At this time, Upper Klamath Lake is open all year to fishing. Anglers must be in possession of an active state license to fish and are subject to refuge regulations that apply to all visitors, including but not limited to those described in the stipulations herein. Game fish species allowed for legal take

include all native and introduced species listed in the applicable regulations. Fishing is permitted in accordance with state and federal regulations to ensure it will not interfere with conservation of fish and wildlife and their habitats. Crystal Creek is open from May 22 to October 31. The closure is to protect spawning redband trout. The entire Upper Klamath Refuge is open to bait fishing with the bag limit of one trout per day. There are no bag or size limits on yellow perch.

Wildlife Observation, Interpretation, and Photography

The refuge provides opportunities for wildlife observation, photography, and interpretation by maintaining a 9.5-mile canoe trail through a mixture of marshland, open lake, and forested shoreline. The meeting of these three environments provides a rich habitat for an abundance of plant life and wildlife species. The canoe trail has four segments: Recreation Creek, Crystal Creek, Wocus Cut, and Malone Springs. Each segment offers spectacular views of the marsh, mountains, and forest. Wocus Cut is best paddled in spring and early summer since it is usually dry by August. Early morning usually proves to be the best time for finding birds on either the canoe trail or adjacent uplands. Smaller birds such as warblers and flycatchers migrate along the edge of the lake using willow, aspen, and cottonwood trees for cover in the spring and early summer. White pelicans, Canada geese, American coot, belted kingfisher, osprey, and bald eagles are other birds likely to be observed along the canoe trail. One of the most interesting plants found in the marsh is wocus, or yellow pond lily. It is a large-leaved water plant with large, waxy, yellow cup-shaped flowers. Access to the canoe trail is at either Rocky Point or Malone Springs boat launches. The canoe trail is open from sunrise to sunset. A vehicle pull-off on West Side Road is also provided for views of the refuge.

Additional interpretive facilities are also at the Refuge Complex Visitor Center which is located at Tule Lake Refuge.

5.5.6 Management and Monitoring Practices

Land Management

Marsh Management

Hank's Marsh and Upper Klamath Marsh units of Upper Klamath Refuge are almost exclusively composed of freshwater marsh habitat. The wetlands are part of Upper Klamath Lake, which is managed by Reclamation. In addition to the lack of water management, the wetlands are closely packed with vegetation over the majority of the refuge. The vegetation makes prescribed fire logistics difficult to accomplish small fires for the purpose of opening up the wetlands. Therefore, the refuge has little management opportunity or maintenance requirements on the refuge, thus refuge personnel spend little time on marsh habitat management.

Grazing

The Service allows grazing on refuge lands with domestic livestock, primarily cattle (*Bos primigenius*), but possibly including goats (*Capra aegagrus hircus*) and/or sheep (*Ovis aries*). Grazing has occurred intermittently on the refuge for decades. In recent years, approximately 200 to 400 acres (approximately 100 AUMs) in the northwest corner and approximately 1,200 to 1,800 acres (approximately 460 AUMs) in the northern portion of the refuge (Barnes-Agency Unit) have been grazed annually (Figure 5.21). Together, these acreages comprise approximately 6% to 10%

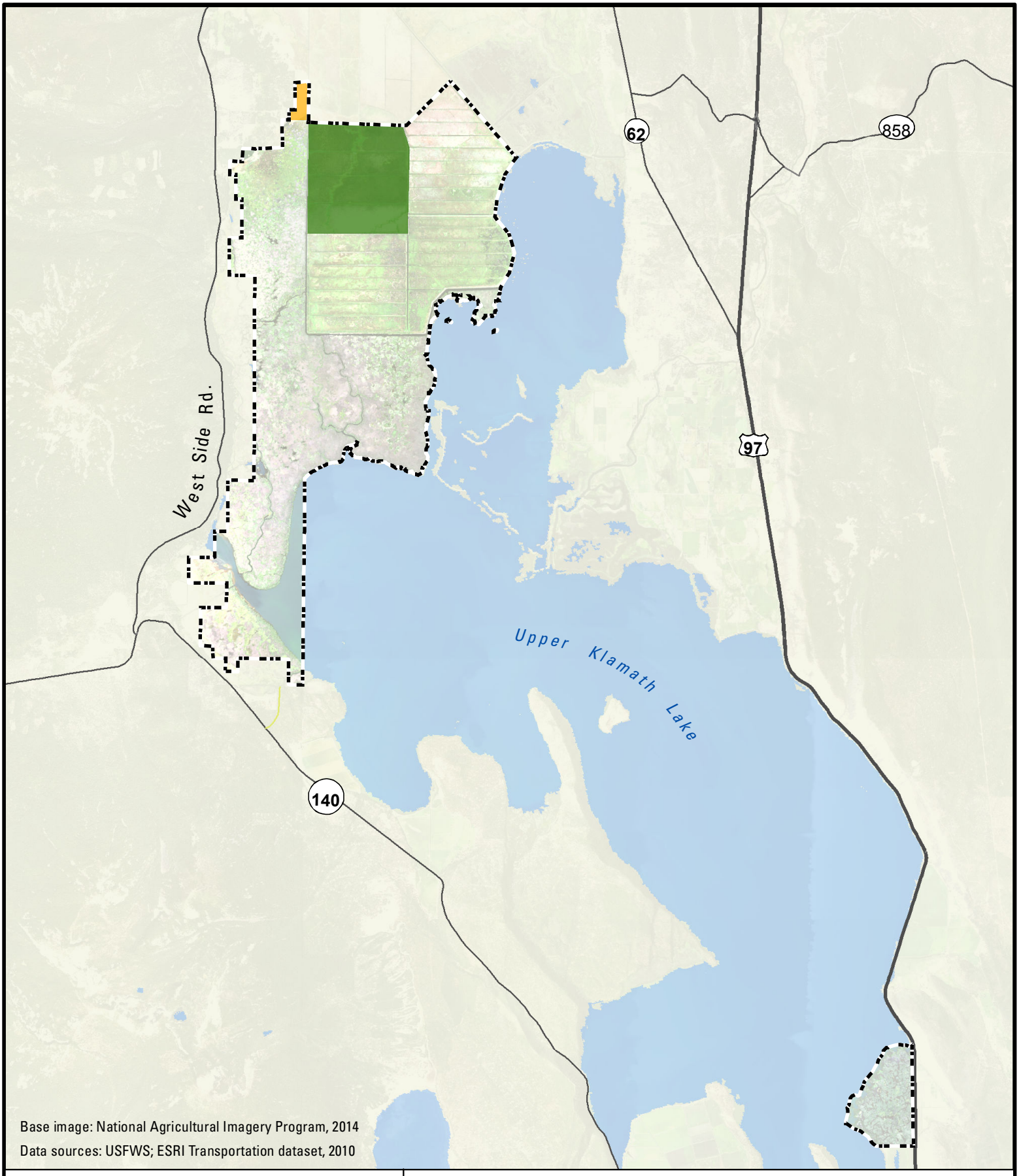


Figure 5.21. Grazing and Haying Activities - Upper Klamath Refuge

of the almost 23,100 acres within the approved refuge boundary. Plants grazed include grasses (e.g., *Agropyron* spp., *Agrostis* spp., *Poa palustris*, *Poa pratensis*, and *Hordeum* spp.); sedges (e.g., *Carex nebrascensis*, *Carex rostrata*, *Elocharis acicularis*, and *Juncus balticus*); rushes; a mixture of forbs; and similar species. Especially in the Barnes-Agency Unit, invasive plants such as reed canarygrass (*Phalaris arundinacea*), poison hemlock (*Conium maculatum*), perennial pepperweed (*Lepidium latifolium*), Canada thistle (*Cirsium arvense*), and musk thistle (*Carduus nutans*) are also targeted for grazing (Service 2013). All of these species grow on the refuge without the need for planting, irrigation, fertilization, or pest management/pesticide use.

Grazing, along with other management techniques such as haying and mowing, is used to help achieve habitat and associated wildlife objectives **(Appendix F). Grazing is used to achieve the following CCP objectives: 1.1 marsh objective and 1.3 short-grass objective for interim management of the Barnes-Agency Unit. Grazing introduces an environmental disturbance event** to create openings in dense emergent or other vegetation, to set back vegetative succession, and thereby enhance habitat and wildlife diversity. This benefits foraging and breeding waterfowl, other water birds, and other wildlife. Because the emergent wetland habitat over much of the refuge is closely packed with vegetation, it is logistically difficult to accomplish small fires to open up the wetlands (Service 2008). **The standard practice of grazing decadent emergent marsh vegetation is allowed when the units are dry.** Grazing and the other habitat management techniques, as appropriate, are used on varying acreages and rotated around different parts of the refuge to ensure that a diversity of habitat types, qualities, and successional stages are always available for use by refuge wildlife. The mixture, acreage, locations, and timing of management techniques used during any particular year are based on an assessment of current and likely future habitat conditions and wildlife needs, including the potential availability of water; the availability of adequate funding, staff, and equipment; air quality restrictions; the availability of local farmers, ranchers, and livestock; forage quality; and site conditions (e.g., access, roughness of the terrain, fencing, and other infrastructure). Depending on precipitation and lake levels, grazing occurs in the spring, summer, and/or fall. The acreage available for grazing in the northwest corner of the refuge during any particular year depends on how much of the seasonal marsh was flooded by waters from Upper Klamath Lake. The Service does not control water levels in the lake.

Grazing practices at Upper Klamath Refuge involve the use of a variety of infrastructure existing on the refuge and the personnel to manage the livestock. As a result of a past property acquisition in the northwest corner of the refuge (Barnes-Agency Unit), the Service already owns and makes available some of this infrastructure to a rancher, as appropriate. In the Barnes-Agency Unit, this includes barns, corrals, a loading/unloading ramp, and permanent fencing and gate(s) (which prevent livestock from trespassing between refuge and other public and private lands) along the west side of Fourmile Canal and the south side of Brown Road. Ranching personnel are on site as needed throughout the season to monitor the livestock and perform appropriate ranching-related functions, including fence maintenance, providing and positioning any watering facilities and mineral blocks, and operating the equipment. Some or all of this equipment is on the refuge throughout the season.

Grazing on a refuge is conducted through use of a SUP issued by the Service. Under such a permit, a rancher pays the Service, on an AUM basis, to graze a particular location(s) on the refuge for a specified period of time. AUM fees are based on local fair market values or set through a bidding process.

Haying

Haying of refuge lands includes the cutting, drying/curing, raking, bailing, temporary storage (stacking of bales), and removal of vegetation (including plant heads, leaves, and stems), usually for livestock fodder. The most common plants hayed on the refuge include pasture grasses, rushes, and sedges. All of these plants grow on the refuge without the need for planting, irrigation, fertilization, and/or pest management. There have been haying programs on the refuge for decades. In recent years, approximately 200 acres in the northwest corner of the refuge have been hayed annually (see Figure 5.21). Because one of the principle purposes of haying would be to create openings in vegetation and thereby enhance habitat diversity, haying operations are rotated around different areas of the refuge.

Haying, along with other management techniques such as grazing, mowing, and prescribed fire, are used to help achieve habitat and associated wildlife objectives (Appendix F). An example objective could be to introduce an environmental disturbance event by using haying to open up dense emergent or other vegetation, to set back vegetative succession, and thereby enhance habitat and wildlife diversity. This could benefit foraging and breeding birds and other wildlife. Because the emergent wetland habitat over much of the refuge is closely packed with vegetation, it is logistically difficult to accomplish small fires to open up the wetlands (Service 2008). Therefore, the other habitat management techniques are used more frequently. The mixture, acreage, locations, and timing of management techniques used during any particular year is based on an assessment of current and likely future habitat conditions and wildlife needs, including the potential availability of water; the availability of adequate funding, staff, and equipment; air quality restrictions; the availability of local farmers, ranchers, and livestock; forage quality; and site conditions (e.g., access, roughness of the terrain, fencing, and other infrastructure). In the northwest corner of the refuge, the area that is hayed is a seasonal wetland that includes various plant species such as grasses (e.g., *Agropyron* spp., *Agrostis* spp., *Poa palustris*, *Poa pratensis*, and *Hordeum* spp.); sedges (e.g., *Carex nebrascensis*, *Carex rostrata, Elocharis acicularis*, and *Juncus balticus*); rushes; a mixture of forbs; and similar species. The amount of this area potentially available for haying during any particular year would depend on how much of the seasonal marsh was flooded by waters from Upper Klamath Lake. The Service does not control water levels in the lake.

Haying requires use of a variety of farm machines on the refuge (potentially including tractors, swathers/windrowers, hay rakes, hay balers, and trucks) and the personnel to operate these machines. Personnel are on site as needed throughout the season to monitor the field(s) and perform appropriate farming-related functions, including operating the machines. Some or all of these machines could be on the refuge throughout the season.

Haying on refuge is conducted through the SUP issued by the Service. Under the SUP, the farmer is required to record and submit to the Service the number and weights of hay bales removed from the refuge. The farmer pays the Service for the tonnage of hay harvested and the price is based on local market rates.

Invasive Species Management

The Service will continue to use a variety of methods to manage invasive species (especially purple loosestrife) on the refuge, including mowing, prescribed grazing, and the application of pesticides. In some years, herbicide is applied during the warmer season on the dike roads of the Barnes-

Agency Unit. As described in Section4.5.2, pesticide applications will continue to be evaluated and permitted consistent with the DOI and the Service IPM Plan and other relevant policies, and PUPs. Table 5.32 summarizes the types of pesticides authorized for use to control invasive species as described in the wildlife, habitat, and facilities management programs in recent years (i.e., 2011–2015). Although these pesticides have been approved for use, very few acres have been treated with chemicals for invasive species control. **In 2015, Aminopyralid was used on 34 acres as a spot treatment on common St. John's wort; 2,4-D butoxyethyl ester was used on 26 acres for spot treatments on five hook bassia and perennial pepperweed; and AquaNeat, a glyphosate product was used on 8 acres for spot treatments of phragmites, purple loosestrife, and reed canary grass.** For management purposes the Service reviewed and approved the potential use of pesticides on Upper Klamath Refuge when the Barnes-Agency Unit tract was acquired.

Fire Management

Prescribed burning is not typically used for refuge vegetation management due to the risks of burning on the peat soils there (Johnson pers. comm. 2015).

Fish and Wildlife Management

Wildlife Monitoring

Periodic waterfowl surveys are flown September through April ideally twice a month, but often only once a month and sometimes not at all depending on conditions. Areas surveyed off refuge include wetlands from Wood River Ranch north of Upper Klamath Lake down south to the Fall River Valley. The pilot and one observer fly in a high-wing airplane at less than 80 mph and about 150 feet above the ground. A small voice recorder is used to capture the data. Transects are flown 0.5 mile apart. When large mixed flocks are present, which is common during migration, a first pass is made to estimate the total numbers followed by a second pass to determine the percentages of the various species. No visibility correction factor or doubling of numbers is done; the actual numbers counted are used to tally the total number of birds. By taking the average of the number of surveys in the month and multiplying by the number of days in the month the waterfowl use days by species can be calculated, (i.e., one mallard present for 30 days equals 30 use days).

Table 5.32. Upper Klamath Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

Habitat/Facility Type	*Invasive Species*		*Pesticide*	
	Common Name	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, range, and riparian.	Five-hook bassia	*Bassia hyssopifolia*	Weedone 638	2,4-D butoxyethyl ester
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, range, and riparian.	Reed canarygrass	*Phalaris arundinacea*	Rodeo AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, range, and riparian.	Poison hemlock	*Conium maculatum*	Rodeo AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate

Table 5.32. Upper Klamath Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

Habitat/Facility Type	*Invasive Species*		*Pesticide*	
	Common Name	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, range, and riparian.	Purple loosestrife	*Lythrum salicaria*	Rodeo AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, and range.	Common mullein	*Verbascum thapsus*	Milestone Specialty	Aminopyralid
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, range, and riparian.	Perennial pepperweed	*Lepidium latifolium*	Weedone 638	2,4-D butoxyethyl ester
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, range, and riparian.	Phragmites or common reed	*Phragmites australis*	Rodeo AquaMaster, AquaNeat, Glyphosate 5.4	Glyphosate
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, and range.	Canada thistle	*Cirsium arvense*	Milestone Specialty	Aminopyralid
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, and range.	Scotch thistle	*Onopordum acanthium*	Milestone Specialty	Aminopyralid
Fallow/former agricultural, meadow or pasture, non-crop areas, parking lot or roadside, and range.	Common St. John's wort	*Hypericum perforatum*	Milestone Specialty	Aminopyralid

Duck pair counts are typically completed in mid-May or after migrant ducks have left. Two observers on each side of the plane count singles, pairs, and groups of drakes 0.125 mile (660 feet) out from the plane in transects 0.5 mile apart and about 100 to 150 feet off the ground. Data are captured via a small voice recorder. Once the numbers are tallied by species they are multiplied by 2 (to account for only 0.25 mile of the 0.5-mile-wide transect being surveyed and the assumption that birds are evenly distributed) and the number of each species is then multiplied by a visibility correction factor to account for the difficultly of spotting them from the airplane.

Canada goose breeding pair counts are done in mid- to late March using the same protocol and in the same manner as the duck pair counts.

Bald eagles are observed on Upper Klamath Refuge throughout the year including the spring/summer breeding period and the wintering period when local birds are joined by migratory populations.

A general ground survey is conducted annually to estimate use of colonial waterbirds on the refuge. These species are considered representative groups of colonial waterbirds that are relatively common on the refuge.

5.6 Bear Valley National Wildlife Refuge

Bear Valley Refuge was established in 1978 to protect a major night roost site for wintering bald eagles in southern Oregon. The refuge consists of 4,200 acres, primarily of old growth ponderosa pine, incense cedar, and white and Douglas fir.

5.6.1 Physical Environment

Geographic Setting

Elevations within Bear Valley range from 4,090 to over 6,500 feet on Hamaker Mountain.

Soils

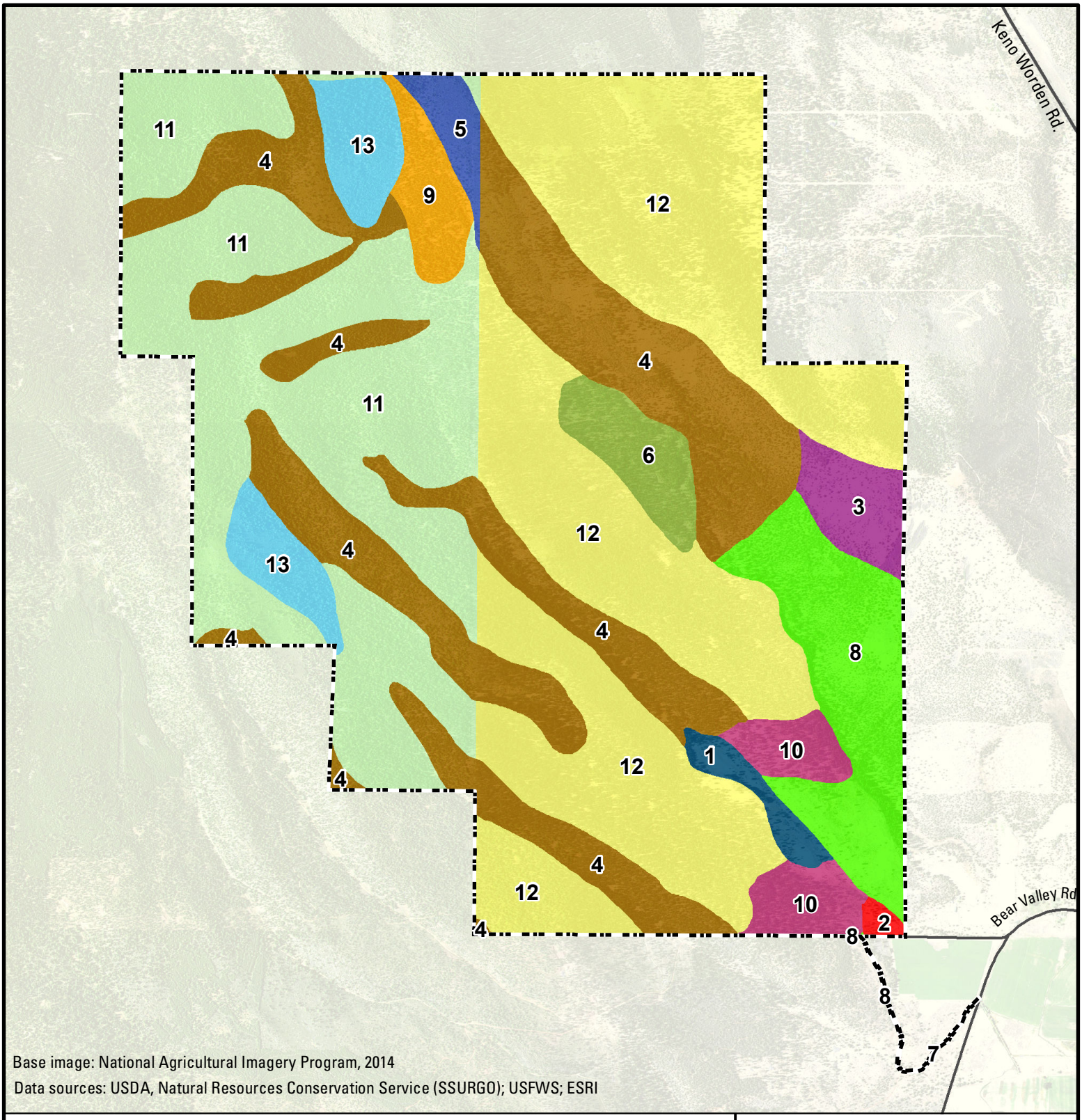
Thirteen soil types have been mapped on the Bear Valley Refuge (Figure 5.22). These soil types fall into one of eight soil series on the refuge, of which the Woodcock and Greystoke are the dominant series. The soils on Bear Valley Refuge occur on slopes and would be subject to erosion from runoff. Soil erodibility from the wind is fairly low on Bear Valley Refuge with most of the refuge ranked as either 1 or 2 (Figure 5.23). However, two soil types on the refuge have a higher degree of wind-based erosion; these are 93 acres of Lobert loam (2% of the refuge) and 41 acres of Calimus find sandy loam (1% of the refuge).

Woodcock: The Woodcock series consists of very deep and deep well-drained soils that formed in colluvium and mudflows from glacial deposits derived from volcanic rocks and volcanic ash. Woodcock soils are on mountains and plateaus. Slopes are 1% to 60%. Surface runoff varies from low to high and the soils have moderate permeability. These soils are used for timber production, wildlife habitat, livestock grazing, and recreation. The vegetation is a forest canopy of mainly white fir with ponderosa pine, sugar pine, Douglas-fir, and incense cedar.

Greystoke: The Greystoke series consists of deep, well-drained soils that formed in residuum and colluvium weathered from andesite of basalt. The term residuum is used when the properties of the soil indicate that it has been derived from rock like that which underlies it and when evidence is lacking that it has been modified by movement. Colluvium is poorly sorted debris that has accumulated at the base of slopes, in depressions, or along small streams through gravity, soil creep, and local wash. These soils are on plateaus and hillslopes and have slopes of 1% to 75%. These soils are used for timber production and livestock grazing. Native vegetation includes an overstory of Douglas fir, ponderosa pine, incense cedar, sugar pine, and white fir. Understory includes western fescue, tall Oregon grape, greenleaf manzanita, snowberry, Pacific serviceberry, spreading dogbane, and squaw carpet.

Hydrology

Surface water resources on the Bear Valley Refuge are limited to a few intermittent streams that carry water during high rain events and following snowmelt in the spring. There are no wetlands or floodplains on the refuge.



Approved acquisition boundary

Soil type

- 1-Calimus fine sandy loam
- 2-Calimus loam
- 3-Dehlinger very stony loam
- 4-Greystoke-Pinehurst complex
- 5-Greystoke stony loam
- 6-Lobert loam
- 7-Lorella loam
- 8-Lorella very stony loam
- 9-Pinehurst-Greystoke complex
- 10-Royst stony loam
- 11-Woodcock-Pokegema complex
- 12-Woodcock association
- 13-Woodcock stony loam

Figure 5.22. Soils - Bear Valley Refuge

0 0.2 0.4 0.6 miles

Base image: National Agricultural Imagery Program, 2014

Data sources: USDA, Natural Resources Conservation Service; USFWS; ESRI

Approved acquisition boundary

Soil Erodibility (scaled, low to high)	% of total area
0	1.9
1	59.9
2	35
3	2.3
4	1.0
5	0
6	0

Figure 5.23. Soil Erodibility from Wind - Bear Valley Refuge

0 0.25 0.5 1 miles

Fire History

Fire plays an important role in maintaining healthy ponderosa pine and mixed conifer forest communities such as those found on the Bear Valley Refuge. Historically, wildfires in these communities consumed the grassy and other herbaceous vegetation on the forest floor, along with the dead branches, needles, fallen trees, brush, and seedlings, while leaving the mature trees largely unharmed. The result was a forest community rather open and park-like, with very few young trees or seedlings growing among the grassy vegetation on the forest floor. Recent studies suggest that the historical fire return interval for the Bear Valley Refuge was, on average, 14 years (Goheen 1999).

A series of incendiary fires were set in the Kesterson timber holdings in Bear Valley and the slopes of Hamaker Mountain in 1919. It is likely that these fires burned a large portion of the Bear Valley Refuge. Another large fire burned in Bear Valley in 1926. Fire scars from both of these fires were evident from examining stumps for the 1999 fire history study.

The Klamath-Lake Counties Forest Fire Association was organized in 1908. This organization was formed to provide protection from fire to the rich timber holdings in the region. As a result of the above fires and other large fires in the 1910 to 1920s timeframe, active fire suppression became very organized and efficient within the Klamath region beginning in the 1920s. By the 1930s a large network of fire crews, dispatchers, lookouts, roads, and equipment was deployed throughout the county effectively preventing most fires from burning in a natural fashion.

Thus, ponderosa pine and mixed conifer communities grew up in the absence of natural, low severity, frequent fires for many decades. In addition, the refuge has been subjected to extensive timber harvest operations. Past timber harvests removed many of the largest and most fire resistant ponderosa pine and mixed conifer species. Coupled with wildland fire suppression efforts, the result has been forest communities that are choked with dense stands of young trees, particularly white fir. The high densities of the existing stands not only affect the health of forest communities and impede the development of stands with large trees (old-growth); they pose a very high fire hazard. The replacement of fire-tolerant species, such as ponderosa pine, with fire intolerant species (white fir) in the absence of natural fire regimes has aggravated the high fire hazard situation on the refuge.

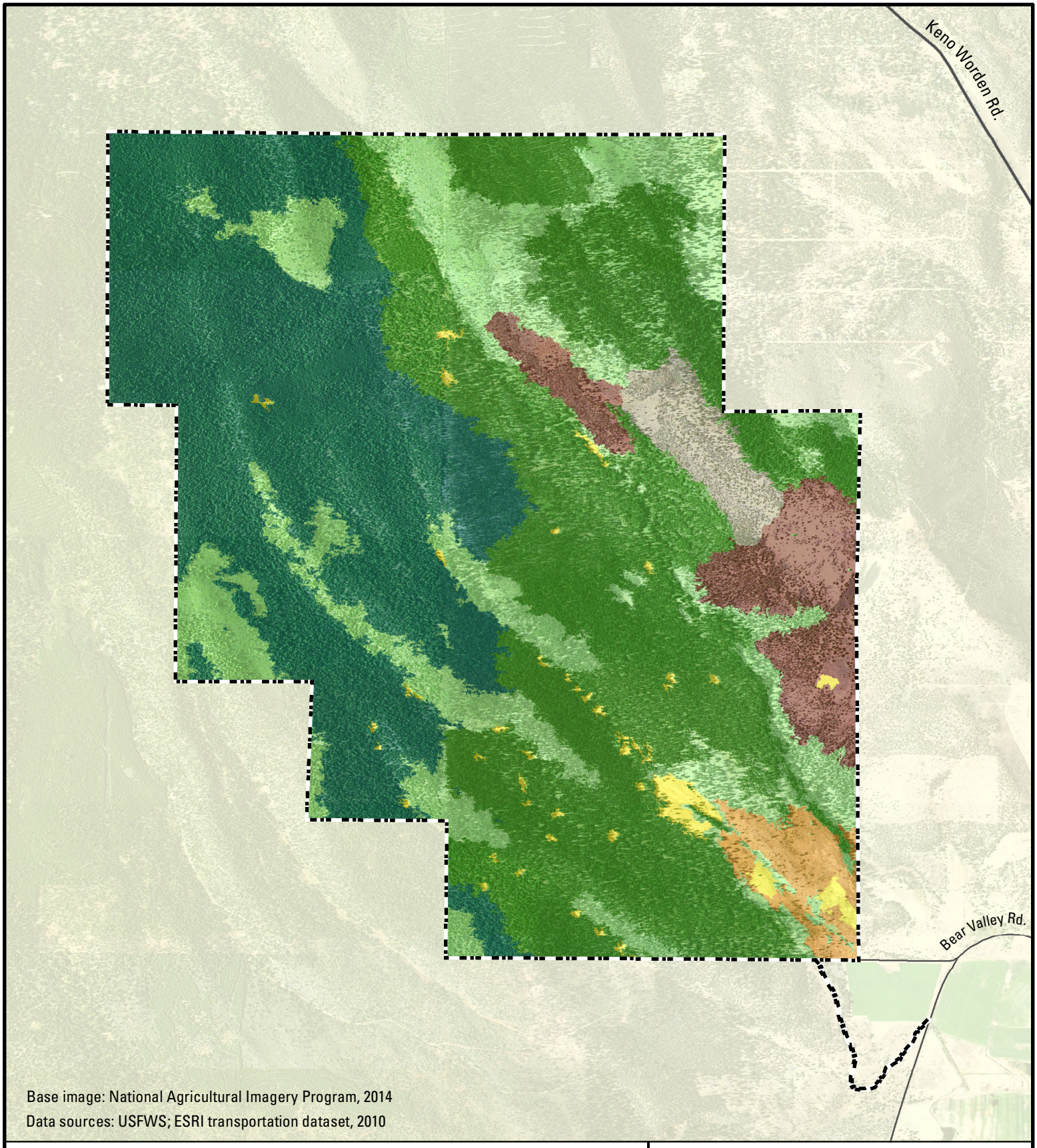
As of 2015, seven fires have occurred within the refuge since it was acquired by the Service in 1978. All were caused by lightning strikes and most of the fires were less than 1 acre and quickly extinguished. In 2001, a lightning-caused fire required numerous retardant drops and a large contingent of firefighters and equipment to control it. This fire was controlled at 5 acres, but crowned into the tree canopy resulting in complete mortality within the fire perimeter.

5.6.2 Biological Resources

Vegetation and Habitat Resources

The Bear Valley Refuge consists of 4,200 acres of forested habitat (Figure 5.24). The dominant species in the forest vary with elevation, slope, and aspect.

There are three different plant communities in the refuge, occupying sites that differ in elevation, slope, and aspect, and therefore moisture and temperature. Drier sites with 8 to 10 inches of



Base image: National Agricultural Imagery Program, 2014
Data sources: USFWS; ESRI transportation dataset, 2010

Approved acquisition boundary
Bunchgrass grassland
Sagebrush shrubland
Mtn. mahogany/ Juniper woodland
Juniper woodland
Open Ponderosa pine forest with shrub understory
Ponderosa pine forest
Mixed conifer forest

Figure 5.24. Vegetation - Bear Valley Refuge

0 0.2 0.4 0.8 miles

annual precipitation (usually at lower elevations or on south- or southwest-facing slopes) support a western juniper, bitterbrush, and bunchgrass community. This community gradually merges with a ponderosa pine-dominated community at an elevation of about 4,600 feet, where annual precipitation averages 14.3 inches. In some areas, this community is intermixed with shrubs, such as bitterbrush and sagebrush, and bunchgrass. At higher elevations and north-facing slopes, the ponderosa pine community merges with other conifers such as Douglas fir, incense cedar, sugar pine, and white fir.

Fish and Wildlife

Birds

Birds occurring on Bear Valley Refuge include northern goshawk, California quail, mountain quail, western screech-owl, northern pygmy-owl, Calliope hummingbird, Steller's jay, mountain chickadee, brown creeper, golden-crowned kinglet, Townsend's solitaire, hermit thrush, green-tailed towhee, evening grosbeak, and bald eagle. More information about the bald eagle is provided in the following section that addresses listed species. Bear Valley Refuge also supports multiple species of woodpecker, flycatchers, nuthatches, warblers, and sparrows.

Mammals, Amphibians, and Reptiles

A variety of wildlife inhabits the forest and meadows of Bear Valley Refuge including ungulates, small mammals, reptiles, and amphibians. Some common species include coyote (*Canus latrans*) and mule deer (*Odocoileus hemionus*). Bear Valley Refuge has a small population of deer estimated at 50 to 100 animals that freely move on and off the refuge onto adjacent federal, state, and private lands. These deer are generally a mule deer/blacktail deer hybrid because the refuge is on the boundary line between the two subspecies. Elk also make a periodic appearance on the refuge, however, their occurrence is sporadic at best. Appendix H provides a list of fish and wildlife species that are known to occur or potentially occur on the Bear Valley Refuge. Although many of the other species of mammals, amphibians, and reptiles included on the list for the Refuge Complex (Appendix H) are expected to occur on Bear Valley Refuge, their presence is undocumented.

Federal- and State-Listed Species

Gray wolf

The endangered gray wolf potentially occurs on Bear Valley Refuge given occurrences within the vicinity, but there are no known modern occurrences.

Bald Eagle

Bear Valley Refuge provides breeding and wintering habitat for one species listed as endangered by the State of California and threatened by the State of Oregon: the bald eagle. The Bear Valley Refuge was established to preserve an important winter communal roost area for bald eagles in the Klamath Basin. In some years, over 1,000 bald eagles have wintered in the Klamath Basin, constituting one of the largest concentrations in the lower 48 states. As much as 64% of the wintering population in the basin uses the roost at Bear Valley between mid-November

and April. Four distinct core roosting areas, or subroosts, have been documented at Bear Valley Refuge. The refuge also has several active bald eagle nests.

The locations of the roosting sites on the refuge protect the eagles from the harsh winter winds, provide access to an unlimited food source (over-wintering waterfowl), and contain a number of old, tall, and large-diameter trees, which are preferred habitat for eagle roosting.

5.6.3 Cultural Resources

Archeological surveys within the refuge have resulted in the recording of several historic sites including an old logging railroad grade, a base camp, a field camp, a collapsed wooden structure, two cabin and homestead sites, and five tin can dumps (D. L. Zerga & Associates 2002; Service 1996b). During a survey in 2001, 10 isolated artifacts were located, nine of which were historic and one prehistoric.

Documentary research revealed that it is very likely that a branch of the Oregon Trail, which later became known as the Applegate Trail, passed through Bear Valley. The route along Bear Creek was apparently not the original route pioneered in 1846, but was highly used by later groups from 1846 to 1869. Due to the intensive use of all roads in the area for logging earlier in this century, the on-the-ground survey could not determine with certainty if any of the numerous roads that traverse the refuge from southeast to northwest were once wagon roads. Therefore, although it is almost certain the second edition of the Applegate Trail passed through the refuge, no physical traces remain.

A more detailed discussion of the cultural resources within the Refuge Complex is included in Appendix O.

5.6.4 Visitor Services

Bear Valley Refuge was established, in part, to protect roosting bald eagles from human disturbance. Accordingly, the refuge is closed to all public entry, except for walk-in deer hunting before November 1, to reduce disturbance to birds.

Hunting

The refuge is currently open for walk-in deer hunting prior to November 1 (Figure 5.25).

Although the refuge is usually closed to visitors, a walk-in deer hunting program that is managed by the State of Oregon is currently allowed. Hunting is permitted in accordance with state and federal regulations and seasons to ensure that it will not interfere with the conservation of fish and wildlife and their habitats. The refuge is included within the Oregon Keno Deer Unit #131. The Keno Unit is open to rifle deer hunting from the first Friday in October for 12 consecutive days; and open for archery deer hunting from the fourth Friday in October for 26 consecutive days. However, the refuge portion of the unit closes October 31 to avoid disturbance to wintering bald eagles. The harvest limit for deer in this unit is one buck with visible antler. In 2013, 138 tags were issued for bow hunting, and 1,045 tags were issued for hunting with a rifle in the entire Keno Unit.

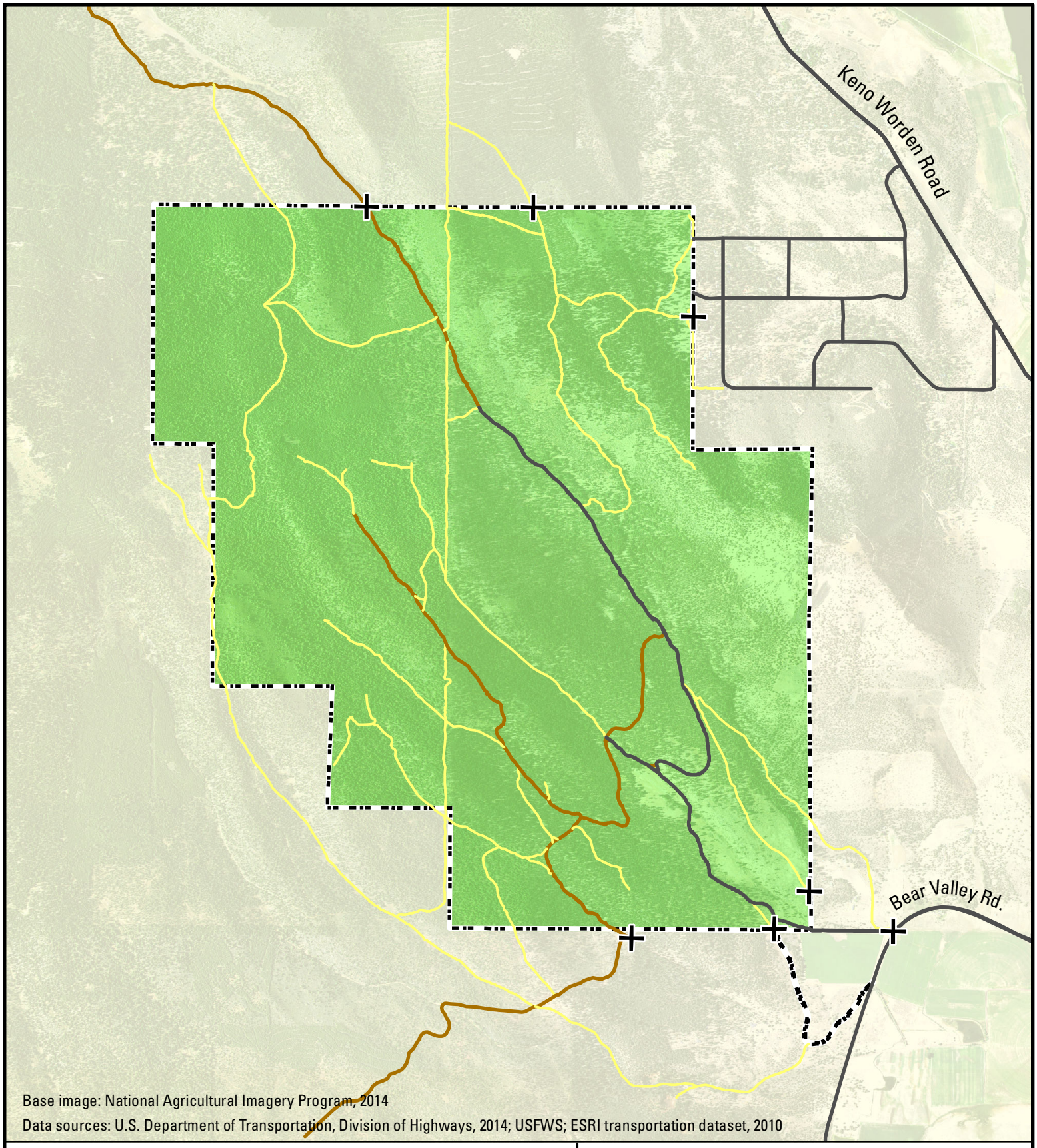


Figure 5.25. Visitor Services-Bear Valley Refuge

Wildlife Observation and Photography

The road commonly used in the past by visitors seeking bald eagle viewing opportunities near Bear Valley Refuge is a private road and those who travel it without permission are trespassing onto private land. For this reason, bald eagle viewing is encouraged at other locations in the Refuge Complex. Bald eagles can be seen in large numbers at various locations around Lower Klamath and Tule Lake Refuges. Eagles feed on the waterfowl that also occur in large numbers and on rodents that live in the surrounding fields. Visitors are encouraged to stop at the Tule Lake Visitor Center in Tulelake, California, to learn of where the highest concentration of bald eagles can be seen.

5.6.5 Management and Monitoring Practices

Habitat Management

Fire suppression in the Bear Valley region has generally converted many stands from fire-resistant, open-grown ponderosa pine to relatively dense stands of fire-intolerant white fir, Douglas fir, and incense cedar. White fir is a less desirable roost tree species for two reasons. It develops poor roost-tree characteristics because it has relatively fine branches and dense tree crowns, and is thus less desirable to eagles. White fir encroachment also appears to preclude regeneration of more desirable roost tree species. Overstocking in many stands, particularly with white fir saplings, coupled with excessive dead and down material has rendered the Bear Valley roost highly susceptible to catastrophic wildfire. In addition to increasing the risk of catastrophic fire, overstocking of timber stands stresses trees leaving them more susceptible to forest pathogens and insect attack and is a threat to the long-term health of many timber stands on the refuge.

A variety of habitat management activities has been implemented on the refuge to resolve these issues, including selective thinning, slash-busting, hand thinning, and prescribed fire. Selective thinning involves the removal of selected trees to reduce overall tree density and promote the recruitment of tree species favored by bald eagles. The work is usually conducted under contract in a timber sale. Slash-busting is a method to reduce fuel loads by use of a rapid spinning steel disk with teeth or spikes that grind, tear, and slash brush, trees, and natural fuel litter into small pieces. Hand thinning involves the use of handheld power chain saws, human-operated pole saws, pruners, clippers, loppers, or other hand tools to reduce fuel loads. Prescribed burning uses fire applied to predetermined areas, under specific environmental conditions, to remove and reduce unwanted fuels such as brush, timber, grass, and logging slash.

In an effort to reduce the risk of catastrophic wildfire destroying vital nesting and roosting resources or spreading into the communities bordering the refuge, thousands of refuge acres have been subjected to hazardous fuels reducing treatments through thinning and prescribed burning.

In 1999, a timber sale was administered in the central area of the refuge, followed by hand thinning with chainsaws and pruners. A slash-busting contract started in 2003 to remove unwanted western junipers competing with the bald eagle-preferred ponderosa pines and Douglas firs. Additional hand thinning projects progressed across the refuge, and a second timber sale was completed in 2004. The sale permitted pre-selected/marked trees to be removed, in turn opening up the canopy, reducing smaller, unhealthy trees, and encouraging larger trees to grow. Prescribed fire, used primarily to burn piles over the past few years, was returned on a larger

broadcast scale in fall 2005. Current air quality standards in the Klamath Falls area has reduced opportunities for prescribed burns in the refuge, because burning is restricted to days when winds will not allow for smoke to impact the non-attainment area.

Since 1999, approximately 50% to 55% of Bear Valley Refuge has experienced some form of fuels reduction treatments. A third timber sale was completed in 2011. Additional slash-busting and hand thinning projects along with more than 1,000 acres of prescribed burning are also planned. Future slash-busting, thinning, and prescribed fire projects will be necessary to restore and maintain the refuge to a fire-resilient condition.

At Bear Valley Refuge, mechanical and prescribed fire treatments are aimed at reducing wildfire risks to the surrounding communities of Keno and Cedar Trails, while protecting and improving the vitality of bald eagle roosting and nesting sites. After years of fire exclusion that resulted in increased tree density and wildfire risk in ponderosa pine and dry mixed conifer forests, the Winema National Forest conducted the first prescribed burns on the refuge in 1989. However, the program was suspended in 1992 after several instances of extreme fire behavior (tree torching and crown fires). Mechanical thinning treatments to reduce tree density and fuel loading were then implemented before prescribed burning was resumed in 1999. The Service continues to use mechanical and prescribed fire treatments to restore forests to more natural conditions and protect neighboring communities from wildfires; however, in recent years prescribed burning has been used less frequently due to air quality issues associated with the Klamath Falls PM-2.5 non-attainment area.

Prescribed pile burning is conducted at Bear Valley Refuge in compliance with the Refuge Complex Fire Management Plan (Service 2001). There are two different pile concerns in Bear Valley: landing piles and hand piles. Landing piles are large piles (often covering an area up to 0.5 acre) generated from a commercial timber sale. The timber sale contractor removes trees per the timber sale contract. The trees are generally whole tree skidded to a landing area where they are processed into logs. Landings are always along roads so that log trucks and other equipment can access the site. The size of the landing is often dictated by the needs of the equipment needed to process the logs. A large mechanized log de-limber and processor will require a big area to pick up and turn the logs the right angle to process them. A large pile of limbs, tree-tops, cull logs, and other un-merchantable material will be generated at each landing. Generally one landing for every 10 acres of forest will need to be established for each timber sale.

On the Bear Valley Refuge, a series of three commercial timber sales generated numerous landing piles. Most of these piles have been burned, but a few residual piles remain which will be burned in the future. Efforts to find alternative methods for landing pile disposal were not successful. Poor access and other factors made these piles unattractive to biomass companies. Leaving the logging residue in the forest increases the risk of higher intensity wildfires. Landing piles are burned only when soils are moist and usually when there is snow on the ground.

The second pile concern on Bear Valley Refuge is hand piles. On-going thinning projects remove small-diameter trees to reduce ladder fuels and restore a more open forest community. Trees are cut by crews with chain saws. The cut trees are then piled in small compact piles and these piles are burned during the winter when the soil is moist. These hand piles generally average 6 feet in diameter and are usually less than 4 feet high. On average 10 to 15 piles per acre are produced during thinning, but the number per acre does increase in especially thick areas. Due to declines in fuels money available to do this sort of work, there is a very low level of thinning currently

occurring in the refuge. Generally thinning is only done using in-house fire personnel and it is usually only done for a few months in the spring and early summer. Current thinning levels treat less than 5 acres per year.

Hand piles generated by thinning are covered with plastic and burned during the winter. Piles are only burned when there is significant snow or completely saturated soils. No pile burning is done in dry years when there is no snow/inadequate soil moisture so piles may accumulate over several years. On average, 25 to 50 hand piles are burned per year, but up to 200 piles may be burned if there is a backlog of piles from previous years.

Invasive Species Management

Bear Valley Refuge contains several populations of noxious weeds, however, infestation is considered small to moderate. The highest priority noxious weed is yellow star thistle, which is located in areas adjacent to the southern access road. The distribution of bull thistle is more widespread; however, its numbers on the refuge are small. Lastly, small amounts of Canada thistle can be found on the refuge.

As described in Section 5.2.6, pesticide applications are evaluated and permitted consistent with IPM practices and other relevant policies of the DOI and the Service. Table 5.33 summarizes the types of pesticides used or proposed for use to control invasive species as described in the wildlife, habitat, and facilities management programs in recent years (i.e., 2011–2015). In recent years, approximately 1 to 10 acres have been treated with pesticides annually for invasive species control on the refuge (see Table 5.34).

Fish and Wildlife Management

Bald Eagle Surveys

Bald eagles are counted on Bear Valley Refuge for the long-term monitoring program. An observation point near the main entrance of the refuge is used to view bald eagles flying out of Bear Valley during the winter months. The age, time, and the number of eagles observed for each morning survey is recorded. The survey starts 45 minutes prior to sunrise and is complete over the next hour.

Bald eagle nesting activity is also monitored on the refuge during the spring. In the recent past, three known nests were monitored each year for nesting attempts and the number of fledged offspring. The three nests are named Roost 1 Nest (#572), Hamacker Mountain (#656), and Chicken Hill (#880). In approximately 2000, Roost 1 Nest was abandoned. Hamacker Mountain nest has blown down, and Chicken Hill nest is documented as an active nest.

Table 5.33. Bear Valley Refuge Invasive Species Management: Habitats/Facilities, Pests, and Pesticides

Habitat/Facility Type	*Invasive Species*		*Pesticide*	
	Common Name	*Scientific Name*	*Trade Name*	*Active Ingredient(s)*
Forested, parking lot or roadside	Common mullein	*Verbascum thapsus*	Milestone Specialty	Aminopyralid
Disturbed area, forested, meadow or pasture, parking lot or roadside, and range	Perennial pepperweed	*Lepidium latifolium*	Telar DF, Telar XP	Chlorsulfuron
Forested, parking lot or roadside	Yellow starthistle	*Centaurea solstitialis*	Milestone Specialty	Aminopyralid
Forested, parking lot or roadside	Bull thistle	*Cirsium vulgare*	Milestone Specialty	Aminopyralid
Forested, parking lot or roadside	Common St. John's wort	*Hypericum perforatum*	Milestone Specialty	Aminopyralid

Table 5.34. Bear Valley Refuge Pesticide Application

Year	*Acreage*
2011	3.4
2012	1.0
2013	1.0
2014	10.0

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